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PARTIAL HISTORY OF THE DEVELOPMENT OF GRAIN THRESHING IMPLEMENTS AND MACHINES

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Some Early Methods.

A simple mechanical means for separating grain from the ear or head was no doubt developed very early in the history of agriculture. A complete history of the successive changes in the means and instruments for effecting this according to an old United States Census Report on Progress of Invention in Threshing Instruments, (24, p. 90-91)¹ would be a curious and interesting chapter in the record of the world's progress. Such a retrospect, could it be made, would show a remarkable uniformity in the methods adopted throughout the world in ancient and modern times. It would show that, until within a recent period, mankind had been altogether unsuccessful in originating or transmitting any essential improvement upon the most ancient plan of which we have any record." (24, p. 90-91)

As was the case with a number of other farming operations which in the early days were mainly performed by hand or by means of very crude instruments, so it was with grain threshing. By reference to Bible history some idea of practices in the far distant past may be obtained.

In American Agricultural Implements, (16, p. 103) it is stated that "It is probable that at first the little grain that was raised was shelled by hand, but as the quantity increased the kernels were whipped from the heads across sticks or poles, or pounded out by a staff or rod." The writer mentioned cites Isaiah xxviii, 27-28 as follows: "'For the fitches' (peas) 'are not threshed with a threshing instrument, neither is a cart wheel turned about upon the cummin' (a seed plant something like caraway); 'but the fitches are beaten out with a staff and the cummin with a rod. Bread corn is bruised, because he will not ever be threshing it, nor break it with the wheel of his cart, nor bruise it with his horsemen.'"

It will be observed that in the foregoing Ardrey calls attention to the fact that different crops were threshed differently. He continues: "Here we have several methods of threshing indicated; peas and seeds from plants were beaten out by a staff or rod, while the grain crops required something more expeditious and elaborate in construction, designated a

¹/ Numbers in parentheses refer to list of citations at end of article.

Note: The mention of manufacturers of threshing machines implies no particular endorsement thereof by the Department of Agriculture.

threshing instrument; but the cleaning was accomplished by winnowing; i. e., by tossing up the threshings, after the straw was raked off, so that the wind might blow aside the chaff and dirt. A club was at some early time attached to the staff, and thus the flail was invented." (16, p. 103)

"The primitive mode of 'treading out the corn (small grain)' upon a smooth circular 'threshing floor' in the open air, beneath the feet of the unmuzzled ox, or other animals, has prevailed among eastern nations from remote antiquity. This tritulating process, however, appears from very early times to have been facilitated by certain instruments. Thus, 'threshing instruments of iron' are mentioned by the prophet Amos;" (Amos, 1:3) "and 'a new sharp threshing instrument having teeth,' at a later period by Isaiah." (Isaiah 41:15) "Smaller grains, having a less adhesive envelope, appear to have been separated by implements analogous to the flail, as elsewhere mentioned by the same prophet." Following the above quotations, the writer of the article cited continues: "Cummin is threshed by the same mode in Malta at the present day" (1860) "and in Syria may still be seen in common use the representative of the new sharp threshing instrument with teeth. It is described as a thick plank or sledge drawn by oxen, and having inserted upon its under surface pieces of stone, flint or iron, projecting from three-quarters to half an inch, by which the ears of corn" (grain) "are torn asunder. Its more ancient form among the Hebrews was frequently that of a square frame with rollers, encircled by three rings or wheels serrated in the manner of a saw. It sometimes resembled in form a cart, by which name it is called in the passage quoted." (Isaiah 28: 27-28) "The threshing floor of level, hard-rolled earth was sometimes covered so as to afford shelter to the laborers during harvest." ***** "It was usually constructed upon an elevation exposed to currents of wind, to carry off the chaff." (24, p. 91)

"Cattle were generally used by the ancients to tread out the grain spread upon the 'threshing floor' - referred to in Deuteronomy xxv: 4; 'Thou shalt not muzzle the ox when he treadeth out the corn' - and also to draw around over the grain the charatz of the Egyptians and the Moreg of the Hebrews, the former having been something like the 'stone-boat' which is used on farms East for gathering stones, but made rough on the bottom. The latter consisted of a sled-like frame between the runners of which spiked cylinders were placed that revolved upon the grain as the rude implement was drawn around. Similar devices were known to the old Romans, by whom they were called traha and tribula. Something of this sort is still" (1894) "used in Eastern countries and in Italy, but one of the common methods of threshing there is by means of large fluted rollers or beaters revolving upon a long horizontal shaft or sweep, one end of which is attached by a ring around a post set in the center of the circular threshing floor, the cattle being hitched to the outer end. As they move around outside of the grain spread upon the floor the rollers turn upon the shaft and beat out the grain." (16, p. 103)

Referring to the Biblical quotation from Deuteronomy Andrews asserts that "Something similar to this ancient manner of threshing is now" (1853) "practiced in many parts of Spain. The sheaves are laid upon a smooth piece of paved ground, and a mule draws across them a little sledge, the

bottom of which is covered all over with pieces of iron; the effect of this is to rub out the grain, as was formerly done by the feet of the oxen. A boy rides on the sledge and drives the mule." (1, p. 119-120) The treading out of grain is still the current (1949) practice for threshing in portions of Egypt, China, and other Eastern countries.

The Flail.

By whom and just when the flail was invented is unknown, but it seems to have been one of the very early instruments used for threshing. It is described by Ardrey as follows:- "The flail has been known among the Japanese from the earliest times, according to their records; either used singly for threshing grain from the straw, or in combination with a stripper, called by them mogi-kogi. This latter is a large comb, with teeth of iron or hard wood. The Japanese implement is attached to a frame or bench, the teeth pointing upward. The grain after being first reaped, is brought to it, and the heads are stripped or combed off between the teeth by being drawn through by hand. The headings are gathered up and carried to a threshing floor, where the kernels are beaten out by flails. The grain is cleaned by winnowing or by screening." (16, p. 103-104)

This crude device in use many years ago has been described by Johnson (18, p. 481) as follows:- "A wooden implement for threshing corn by hand. It anciently was truly a whip, and sometimes had two or more lashes; the modern flail consists of the handle or handstaff, which the laborer holds in his hand, and uses as a lever to raise up, and bring down the swiple, or part which strikes the corn, and beats out the grain and chaff from the straw. The swiple is joined to the handstaff by the caplins or couplings, which are thongs of untanned leather, and sometimes the skins of eels or of other fish. These thongs are passed through holes in the ends of the handle and swiple, and made fast by being sewed together. The whip-flail was in use among the Romans, though the prevailing mode of separating corn from straw among the nations of antiquity was by treading it out with cattle in the open air." ***** "The flail was the universal threshing implement till the introduction of the threshing machine, which is now" (1842) "taking the place of the flail in all countries where capitalists engage in farming." (18, p. 481)

"It is uncertain at what time the flail was first introduced. But it was in common use among the Romans; and throughout the greater part of the empire, as well as among most nations of modern Europe, for several centuries superseded nearly every other implement. (24, p. 91)

"Roman writers make frequent mention of the flail, and the threshing floor is minutely described - its situation, and the best manner of constructing it. In England the flail was the only implement used for threshing corn" (grain) "until 1732, when a gentleman named Menzies, living near Edinburgh, invented the first threshing machine." (1, p. 120)

The author of an article on "How the Southern mountaineers thresh by hand" (22, p. 52-53) described at some length threshing operations witnessed by her as late as 1912. It seems that threshing with a flail was the common custom in some parts of North Carolina - the actual labor being performed at least in part by women. The description of the making of the flails and other equipment used in this primitive threshing is interesting, and is substantially as follows:- "The first step in threshing by hand consists of a trip into the woods to make the flails or wythes." ***** Hickory saplings were chosen. The branches were removed, and the saplings cut to about eight feet in length. "Three feet from the tapering end the fiber of the saplings was beaten mellow with the butt of the axe. Then it was twisted vigorously in the hands until the wood at that point became limp and pliable, and the 3-foot section below it flapped here and there as the flail was swung down from over the shoulder." ***** "The oats were whipped out on a threshing floor laid on a spot of hard dirt in front of the log cabin, being swept up from the ground with a broom. For the wheat, which was later to be ground into flour for the family, an old bed quilt was first spread on the ground, and the threshing floor placed on this." ***** Four rails carried from the nearest fence were first laid in a hollow square; and over these, side by side, as boards are laid in a walk, were placed more rails. "The grain was thrown upon these, and two people, one standing at each end, beat it alternately with their flails, whipping down upon it with a vigorous rhythmic motion. The loosened grain and chaff sift down between the rails, while the straw is held above." ***** "When a sufficient amount had worked through between the rails to choke up the threshing floor, the rails were laid aside, the chaff and grain swept up, and the process of flailing gave place to that of winnowing. The articles required for winnowing, as it is carried on among these Southern mountaineers, are an old bed-quilt or sheet, and a riddle. The riddle is a white pine boxing having four sides. These sides are punctured with a row of holes so that a bottom can be woven into the box with hickory thongs strung back and forth in a basket weave. ***** Holes are left between the lines of thongs large enough to run the finger through. When the riddle, filled with mixed chaff and grain, is shaken in the hands, the litter drops down from it to the ground. But not all mountain threshing outfits are complete enough to include even one of these homemade riddles. Then the threshers ***** use one of the hand-made box measures of the section, and tip the flailings out from one side of this. Winnowing requires the help of a third party. The two women, still standing at the opposite ends of the threshing floor, each took hold of an old sheet by rolling up the corners into a kind of handle and getting a firm grip upon one with each hand. Then together they vigorously whipped and beat the sheet back and forth to make a wind. ***** The third helper called into the work held the box measure, or temporized riddle, out at arm's length and slowly sifted the flailings down before the sheet; whereas the chaff was carried away by the gust and the grain dropped down again upon the threshing floor. Mountaineer women can thresh out from ten to fifteen bushels a day, while twenty bushels is a good day's work for men." (22, p. 52-53)

"The earliest attempt on record to produce an implement of the character of the modern threshing machine was made toward the middle of the last" (18th) "century." ***** "The earliest proposition on record, probably to apply machinery, and perhaps water power to the threshing of grain," *****

"is found in a tract published in London, in 1650 by Ed. Williams. 'He urges a vigorous prosecution of the plan of colonization in that' (Virginia) 'quarter, and states among other reasons, that it would stimulate the invention of labor-saving engines, which were necessary to half-peopled plantations, but were regarded as oppressive monopolizers of labor in over-populous countries. He gave 'an 'explication of the saw-mill, an engine wherewith, by force of a wheel in the water, to cut timber with great speed.' This mechanism he proposed to introduce into Virginia, and finishes his description of it by saying that the artificer might 'easily convert the same to an instrument of threshing wheat, breaking of hemp or flax, and other as profitable uses.' It does not appear that the machine was at that early period ever applied to any of those 'profitable uses.' A number of the first attempts, however, to construct threshing mills in this country were made in the old Dominion." ***** "It is proper, however, before speaking of American machines to look a little at what has been done in Great Britain, where they were first invented. Our own progress may thus be better understood." (24, p. 91-92)

Early Scotch and English machines.

"The first person who ever projected a threshing machine is said to have been the celebrated Jethro Tull, of Shelborne, in Berkshire, the inventor of the drill-plough, and the father of the horse-hoeing husbandry, and of systematic agriculture in England, who died in 1740. In constructing an effective threshing machine he was far from successful. His attempt was immediately followed by that of Michael Menzies, a Scotchman, belonging to the fertile grain district of East Lothian. His more successful machine, patented in 1732, is considered the initial instrument of its class." (24, p. 92)

Ardrey describes the Menzies thresher as follows: - "Michael Menzies, of Scotland, is supposed to have been the first inventor of a power threshing machine, for which he obtained a patent in 1732. This was a contrivance arranged to drive a large number of flails by water power. It is described as a wonderful invention, and 'capable of giving 1,320 strokes per minute, as many as thirty-three men threshing briskly' - decidedly indefinite - and as 'moved by a great water wheel and triddles.' The grain was brought to this machine, as it was to others invented and used during the last century and the early part of this" (18th and 19th) "before portable threshers were introduced. The flail motion was not practicable, and was soon abandoned." (16, p. 104)

According to Mr. Watson "only a bare record of this invention" (the Michael Menzies thresher patented in February, 1734) "is enrolled in the Patent Office, and nothing is known about its construction except that it consisted of a series of flails attached to a cylinder which was made to revolve by means of power derived from a water wheel. The Society of Improvers"(of Scotland) "appointed two representatives to inspect this mill, and their favorable report appears in the Select Transactions of that body. However, nothing more is heard of it." (26, p. 50)

Commenting on the Menzies machine and its inspection by the representatives appointed by the Society of Improvers, Johnson states that "This committee, after various trials, reported it to be 'their opinion that the machine would be of great use to farmers, both in threshing the grain clean from the straw, and in saving a great deal of labor; for one man would be sufficient to manage a machine which would do the work of six.' They further recommended the Society 'to give all the encouragement they could to so beneficial an invention, which, being simple and plain in the machinery, might be of universal advantage.' The Society approved of the report, and acted upon the recommendation." (18, p. 1160)

"In 1772 a slight advance was made towards the present machines by Messrs. Ilderton & Smart" (some writers give the name as Alderton & Stewart) "the sheaves being carried round between an indented drum and a number of fluted rollers,; another by" (William) "Winlaw was far too effective, for it not only threshed out the grain, but ground it at the same time; and it was not until 1786 that anything deserving the name of a threshing machine was introduced." (1, p. 120-121)

According to the U. S. Census Report, (24, p. 93) the Winlaw machine was "patented in 1785."

Mr. Watson gives a somewhat more detailed account of the Ilderton machine, stating that "About 1772" ***** He "built a thresher which worked on the principle of rubbing out the grain, a series of revolving fluted rollers working against a fluted concave, and being kept pressed against the latter by means of springs. This machine performed its work very imperfectly, and was soon taken down. It was seen, however, by Sir Francis Kinloch, of Gilmerton, in East Lothian, who caused a model of it to be made. This gentleman in the course of the same tour, found another thresher in existence at Wark, in Northumberland, and again he secured a model. After a detailed study of these he built a model of his own, embodying certain improvements, and this he took to Andrew Meikle, of Houston Mill, in order to have it tried by means of the water wheel there. The trial was of short duration, for it is recorded that 'in a few minutes the model was torn in pieces,' but the incident stimulated Meikle to tackle the problem himself." (26, p. 51)

"In 1766 a machine which could be moved either by horse or water power, and was said to thresh great quantities of corn in a short time, was presented to the London Society of Arts, by Mr. Evers, of Swillington, in Yorkshire, the inventor of a winnowing machine deposited with the Society." (24, p. 93)

Reference is made to a machine patented in 1792 by a Mr. "Willoughby of Bedford, Notts, the principle of which appears to have been somewhat similar to that of Menzies': ***** "It comprised a series of loose flails made to act upon a grated floor, and turned rapidly round by means of a horse wheel." ***** "The straw was presented by hand to the action of the flails."

"In 1795, an individual of the name of Jubb, residing at Lewes, obtained a patent for an invention of which the principal feature was the passing the straw between two rapidly revolving beaters, under which it was held by two feeding rollers, whence the corn fell into a winnowing machine.

"In communications from M.D. Musigny to the Society of Arts, a curious account is given of a machine worked by one horse, which, walking round a circle of forty feet, caused a cylinder, upon which thirty-two flails were placed, to revolve at the rate of twenty revolutions to one of the horse wheel." ***** "Another plan, patented in 1796 by John Steedman, of Trentham, has also been exhibited, by which a number of flails, fixed on a rotatory cylinder were made continually to play upon a given spot on a circular table; which, revolving horizontally, brought a fresh supply of straw under their influence." (18, p. 1161-1162)

A machine "was built by Michael Stirling, a farmer near Dunblane, about 1758, in which the principle adopted was that of the flax mill. A perpendicular shaft, carrying four long blades or arms, revolved inside a cylinder of about eight feet in diameter. The corn was fed through an opening in the top, and the grain beaten out by means of the arms or scutchers. The straw was withdrawn from an opening in the side, while the grain dropped through a riddle, which formed the bottom of the cylinder, to a fanner below. This machine seems to have made tolerably good work in threshing oats, but with wheat or barley it did little more than break off the heads." (26, p. 50-51)

"Meikle's first thresher appears to have met with no better success than its predecessors, but in 1787 he erected a really satisfactory machine. This was built for a Mr. Stein at Kilbagie, in Clackmanshire, the bargain being that Mr. Stein supplied the materials, and that if the mill failed to give satisfaction Meikle was to receive nothing for his work. A second mill was erected immediately afterwards at Middletown, in Northumberland, and was so successful that it was immediately copied by various other wrights in the district. Meikle, indeed, took out a patent for his machine, but he seems to have been quite powerless to enforce it, and apparently got nothing by the sale of manufacturing rights." ***** "Meikle's specification for his patent shows a machine of simple construction, consisting essentially of a pair of fluted feed rollers, and a drum revolving inside a concave. The drum carried four beaters with sharp edges, and was made to revolve at some two hundred revolutions per minute. Meikle's original design made no provision for separating the straw, chaff and grain; the grain and chaff were shaken out by hand, and the latter separated by an independent set of fanners. Very soon afterwards, however, there was added a set of revolving rakes which drew the threshed material over a riddle, and a fanner was placed underneath." ***** "The modern type of shaker was a much later invention." (26, p. 51-52)

A somewhat different account of the Meikle machine - especially as to dates - has been given by another author, which is as follows:-

"The machine which was more properly the basis of those now in use in Scotland and elsewhere, was brought out in 1785, by Andrew Meikle, of Tyrringham, in East Lothian, through a gentleman named Stein, who had long seen the defect of the rubbing process, and agreed with the son of Mr. Meikle

to build him a perfect instrument. The machine was completed in 1786. It introduced the corn between two rollers, and threshed it by four beaters fixed upon a revolving drum. Previous to obtaining a patent an improvement was made upon the original form of the beaters by substituting for a flat surface a comparatively sharp edge, thus 'scutching out the grain,' as he termed it, by acting in the direction of the ear, a modification not easily explained without a cut. (24 p. 93-94)

"In a work on Implements, published by Mr. Ransome, will be found copies of the original drawings attached to Meikle's specification; they are very interesting, because they show how perfectly successful this first design of Meikle's must have been, and there can be no doubt but that it answered well."***** "Although Meikle's machine was considered to be thoroughly successful, yet it did not come into use for more than ten years after." (1, p. 121)

James Meikle, the father of Andrew Meikle, is reported to have introduced into Scotland from Holland, at the instigation of Andrew Fletcher, of Saltoun, "a pair of fanners and the required iron work for a barley mill."***** "The mill was erected and set to work." ***** "For many years it was the only one of its kind for making pot barley in the United Kingdom. In 1710 James Meikle successfully invented a winnower or fanner, which owing to religious prejudice against artificially created wind ('Devil's wind' as it was called) only slowly came into general use." (20, p. 26)

In commenting on the Meikle thresher Ardrey states that "Circular rakes or beating-cylinders were added in 1789, but a fanning mill was not provided till 1800, when at last a complete 'separator' was produced, threshing, cleaning and delivering the grain at one operation. Still these machines were 'stationary' being generally put up in buildings, and the grain was drawn to them."

"It has been generally supposed that the threshing cylinder was first invented and perfected, next the straw separating devices, and then the cleaning, and that thus one thing after another was invented and applied until the present perfection had been attained, but early inventors of threshing machines, both in Great Britain and in this country, like those of reapers, reached too far at first. They covered the whole ground in theory before any main features had been made practical; hence the combination of a number of undeveloped principles, working imperfectly, of course, rendered the whole too difficult to manage and unfit for general use. Afterward open-cylinder threshers - called 'chaff-pilers' by some, 'bob-tails,' 'ground-hogs,' and 'bull-threshers' by others - were made and put upon the market successfully. About this time 'traveling threshers,' which went around the fields after the grain, were used to some extent. These opened the way for those that carried the separating attachments, which latter were improved as use pointed out the necessity until, having become practical throughout, the 'separator' absorbed the trade to the exclusion of the older or simpler forms of threshers, and further development has separated the 'separator' into several different classes, each of which has been substantially perfected."

"In a work describing the 'Implements of Husbandry Used in Scotland' by Andrew Gray, engineer, published in 1814, is a description of a thresh-

ing machine which seems to have been a complete separator to be driven by two horses attached to a stationary power. Except that it was not portable, it had all the general principles of a modern separator, even to grading the grain, delivering two qualities while in operation - on one side the heavy kernels, on the other, the light or screenings. The inventor's name is not given." (16, p. 104-105)

"Steam was applied to the business of threshing upon the example farm of Lord Ducie, at Whitfield, where a machine with some valuable modifications was constructed under the directions of his manager, John Morton, and was driven by an engine of six horse-power."

"In 1789 the first machine with a rake and fan attached, to perfect the cleaning of the grain, was invented, it is believed by J. Bailey, of Chillingham. In 1795 Mr. Wigfall, of Lynn, patented some improvements in which he attempted to combine the stroke of the flail with revolving beaters. The latter were loosely attached by short bits of chain instead of being fixed, as in Meikle's scutchers. The grain was carried to the fan by a shaking screen and rolling cloth on an endless arch."

"About the year 1800 or 1801 the Society of Arts first offered a premium of thirty guineas or a gold medal for a threshing machine. The medal was accordingly adjudged by the Society, in 1810, to H. P. Lee, Esq., of Maidenhead Thicket, who, finding the machines then in use so complicated, inefficient, and liable to get out of order, had one constructed under his own directions, which was highly commended for its simplicity and effectiveness. In it rollers were first dispensed with for feeding the straw to be threshed. It was three feet in diameter, and two and half feet in length, and with two horses would thresh about twelve bushels in an hour. It consisted of four vanes or beaters, fixed to an axis revolving within a drum or cylinder, formed of iron plates grooved or ribbed parallel to the axis, and connected by wooden curbs so as to admit of being placed nearer or further from the beaters, according to the kind of grain to be threshed." ***** "It was subsequently improved by Mr. William Lester, of Paddington. Another invention, called the bolting machine, afterward much improved by R. Garrett & Son, of Leicester, was highly spoken of at a later period. A patent was taken out in England over twenty years ago" (before 1840) "by Joseph Atkinson, of Braham Hall, Yorkshire, for a machine said to have been previously patented in this country by S. Turner, of New York." (24, p. 94-95)

Reference to the Atkinson thresher is made by Johnson as follows: "The latest patent which is at present in operation is one taken out by Joseph Atkinson, of Braham Hall, Yorkshire, which appears to be of American origin. The threshing or beating-out process is obtained by means differing from any previously mentioned; the drum being surrounded by a series of pegs, so arranged as in its motion to pass similar rows of pegs placed at intervals in a concave, surrounding nearly one-half of the circumference of the drum." (18, p. 1168)

"Many other threshing machines of various degrees of merit were introduced in Great Britain during the first half of this" (19th) "century. Hand threshing machines were quite common, and received several improvements by Ransom and other large manufacturers. The machines in use in Scotland

twenty years ago" (1840) "were generally on the principle of Meikle's, and combined all the later improvements. Those in use in the Eastern part of England were generally portable threshers, without rakes or fanners attached. There was much difference in the performance of different machines." (24, p. 94)

"English threshing machines differ from Scotch in this important particular. In the Scotch the beater strikes upward, while the corn is held fast between two rollers (these rollers are about four inches in diameter, made of cast-iron and fluted), the concave, or breasting having but little to do with the operation, while in the English machines, it plays a most important part, as the corn is rubbed out between it and the beaters, instead of being merely scutched. Scotch cylinders are close drums, while the English are generally open, the beaters being fixed on arms radiating from the shaft."

"The modern English threshing machine usually consists of a cylinder, to which several beaters are attached. The beaters are formed in various ways, being sometimes square bars of wood, with a metal face, sometimes concave bars of iron, at others again round iron bars; in the machines" ***** "called Vandyke machines, the beaters have notched faces, which revolve in a similar notched faced breasting."

"Messrs. Barrett, Exall & Andrews, of Reading, are the patentees of a new form of machine constructed entirely of iron. The adjustment of the concave to the beaters has always been a great defect in the old machines; in theirs they have a most ingenious contrivance for effecting it; the breasting is formed of bars, with grooved faces working through slots in the side of the machine, and brought nearer to, or carried further from the drum by means of circular discs; these work round its center with a continuous grooved worm cut in their faces, in which the breasting bars move; this arrangement allows the bars to separate wider from each other as well as more distinct from the drum; and thus gives the large corn, as beans, peas, &c., a wider space to move in."

"Portable threshing machines, and the horse work attached complete, are now made by all the leading machine makers, and are so constructed that the machine packs upon the gear, and the whole mounted upon two wheels, is easily conveyed from place to place." (1, p. 123-125)

American Threshing Apparatus.

"The farmers of the thirteen colonies along the Atlantic coast naturally began with farming methods very similar to those they had known in Europe. They used practically the same implements and tools. That was still true in 1775." ***** "By beating with a flail, or by driving animals over a threshing floor, the grain was removed from the head. Then followed winnowing and feeble efforts to clean grain from the chaff and dirt. Not much grain at a time was made available for human consumption. Seven bushels of wheat or eighteen bushels of oats could be laboriously threshed with a flail in a day; sometimes horses were used to trample out the grain."

Threshing, a long tedious job, was an all winter's task. (Today a few men with a modern, fully equipped 28-inch by 46-inch thresher can easily thresh and clean 100 bushels per hour.) The farmers of the Revolutionary War period were using methods and equipment not much, if any, better than those of the Biblical days of Abraham and Joseph. Virtually no progress had been made in agricultural production for century upon century." (28, p. 201)

"The flail," ***** "and the primitive system of treading out grain by cattle, continued in use as the favorite modes during many years of the present" (19th) "century. The former prevailed in most of the Northern States, while in parts of Pennsylvania, in Delaware, the eastern shores of Maryland and Virginia, and we believe in Rhode Island, grain was generally trodden out by oxen or horses as the more expeditious method. Horses were preferred for this work. A crop of 3,000 bushels could thus be threshed and secured from 'the best laid schemes of mice and men' in ten days, which would employ five threshers with the flail for 100 days. The treading floors were from 40 to 130 feet, more commonly 60 to 100 feet in diameter, with a path 12 to 14 feet wide near the periphery upon which the grain was laid. The horses were led round at a slow trot, in platoons equidistant from each other, so that four ranks could preserve the distance of one-fourth of a circle, and represent the four cardinal points. The floors were sometimes removed from field to field, but permanent floors made hard and smooth, and kept so by careful use were preferred. They were commonly fenced round, sometimes with an outer and inner fence."

"Toward the end of the last" (18th) "century Mr. Benjamin Sylvester, of Caroline County, Maryland, introduced the use of a roller to be attached to the horses upon the threshing floor. It consisted of a good piece of white oak six and one-half feet long by 12 to 15 inches square, which was reduced to an octagon or eight square, and encircled at each end with an iron ring, and had an iron axis in each end. Each of the eight planes were bored with about a dozen 2-inch holes, in which were inserted stout pegs of oak, alternating with those in the next row, and made shorter at one end of the roller than the other, to fit them for running in a circle. This appendage to the threshing floor cost about \$12.00, and drawn by three horses, with four men to turn the straw, would thresh a floor of 30 bushels in favorable weather in two hours, or from 60 to 80 bushels in a day. It was introduced into Kent County, Delaware, by Judge John Clayton, who after an experience of over twenty years in preparing for market an annual crop of five hundred to eight hundred bushels of wheat, and as many of oats, considered it superior to any other known mode of threshing. George Cummins, Esq., a senator from that County, and a large farmer, continued its use for the same length of time, and with Mr. Nicholas Ridgely, of Dover, whose account of it was published in the Memoirs of the Philadelphia Society for Promoting Agriculture in 1816, and other experienced farmers, concurred in the opinion of Mr. Clayton. Although a Scottish threshing machine was about that time introduced into some parts of the State, the wheat from Kent County was all threshed in the manner above described, and was said to be more sought after, and to bring a better price at Wilmington than any other."

"A good threshing machine of moderate cost was a desideratum, however, with the mass of farmers, and as the Scotch machines were expensive, the attention of American farmers and mechanics had been long turned to the construction of an instrument adapted to the circumstances of the country. An

effort in this direction appears to have been made before the Revolution. In the Pennsylvania Magazine, or American Monthly Museum, v. 1, for 1775, is a plate and description of a threshing machine constructed with some improvements after a model shown by Mr. Ferguson in his lectures in London. In the account of it the maker is said to have heard of machines for threshing grain erected in America, but had never seen, or heard a description of them. We have met with no other reference to such inventions in this country during the colonial period. We find our mechanics, however, immediately upon the organization of the Patent Office, prepared to put on record their inventions in this line, and it is probable some of them may have been made much earlier."

"The first patent issued by the Secretary of State for a threshing machine was dated March 11, 1791, being the seventh on the records of the office. It was to Samuel Mulliken, of Philadelphia, who on the same day received Letters Patent for machines for breaking and swingling hemp, for cutting and polishing marble, and for raising a nap on cloth, &c." ***** "On the second of August of the same year another patent was recorded for a threshing machine by William Thompson, of Virginia. In the following year Colonel Alexander Anderson, of Philadelphia, an extensive distiller, who made some important improvements in the application of steam to his own branch of manufacture, endeavored to supply the desideratum of a threshing machine. His machine, a model of which was deposited with the American Philosophical Society, was not patented. But one erected upon its plan in Maryland was found to answer well. After a time the wheel warped so as to impede its action, and from want of confidence or energy in the owner, and the absence of the inventor, it was laid aside."

"In 1794 two patents for threshing machines were taken out by Virginians, one dated April 28, by William Hodgson, and the other November 5, by James Wardrop of Amptill, in that State. Wardrop's machine," ***** "was introduced in England in 1796. It was made with flails or elastic rods twelve feet in length, of which twelve were attached in a series, having each a spring requiring a power of twenty pounds to raise it three feet high at the point. A wallower shaft with catches or teeth, in its revolution successively lifted each flail in alternate movements, so that three of the flails were operated upon by the whole power, viz., twenty pounds. The whole weight to be overcome was 120 pounds, and the machine was worked by two men. The flails beat upon a grating to which the corn to be threshed was fed by hand." ***** "Patents were taken out in March, 1797, by William Booker, also of Virginia, and in November by Richard B. Elliott, of Massachusetts, who were followed in June, 1798, by Thomas C. Montin, who patented a threshing machine, making nine inventions of that kind in eight years. The next machine brought before the public was that of Christopher Hoxie, of Hudson, New York, patented August 20, 1801. It was considered more promising than any of its predecessors, but did not come into general use."

"During the year 1802, a Mr. Prentiss, from Edinburg, erected in Pennsylvania, New Jersey and Delaware, six or seven machines upon the Scotch principle, which were found to answer well. But on account of the extreme care required in feeding them, and the inability of common workmen to keep them in repair, the builder being engaged in another business at a distance, prevented their general adoption. The increased demand for American bread-stuffs in Europe during the continental wars, and the impulse given to American agriculture about this time, produced frequent attempts to project

a threshing machine adapted to general use. In July of this year two patents were issued for threshing and cleaning grain--one to Ezekiel Miller, of New York, and one to Joseph Pope, of Boston, afterwards of Hallowell, Maine, a very ingenious mechanic," ***** "Twenty years after, and four years before his death, Pope received another patent for a machine for the same purpose." (24, p. 95-97)

Another authority probably referring to the same machine (although he gives the name of the inventor as Jacob instead of Joseph Pope, but states he was of Boston, Massachusetts, and later of Hallowell, Maine) gives the following description of the Pope thresher:-

"According to one responsible authority this was still a hand machine as late as 1826. 'By turning a crank a series of mallets or swingles came over upon a table on which the heads of the grain was pounded out. It threshed the grain well, but it was found to be harder work to turn the crank than to swing the flail.' This machine was later provided with horse power, and seems to have made considerable headway subsequent to 1825." (21, p. 162-163)

"In October, 1803, J. F. Turner, of Delaware, followed with a threshing machine, and during the following year patents were issued to Thomas Barnatt, of Philadelphia, for threshing and cleaning grain; to Samuel Houston, of Virginia, for the Columbian threshing, break, and cleaning fan; and to James Deneale, of Dumfries, in the same State, for an improvement in threshing machines. B. B. Bernard, of Virginia, and Simon Willard, Jr., of Hudson, New York, took patents in 1807, the former for a simple thresher, and the latter for threshing and cleaning. But one patent was given in 1808, four in 1809, and six in 1810 for threshing and cleaning grain, including one by Isaiah Jennings, of Brookfield, New York." ***** "The number of threshing machines patented during the next twenty-five years, including those which combined other operations and horse power was over 240, or nearly ten annually upon an average."

"In 1815 the Trustees of the Massachusetts Society for promoting Agriculture offered, among others, a premium of \$100. for the most approved machine for threshing and separating grain, adapted to a farm of medium size, to be claimed before the first of June, 1816. In the summer of the last-mentioned year a Mr. Dumbleton, from England, introduced in the Middle States a threshing machine which was thought at the time to supply all that was desirable. He erected one at Port Penn, Delaware, which gave complete satisfaction. It was speedy, clean in its threshing, easy of management and portable." (24, p. 97) (No description of this machine is given.)

"On March 30, 1821, M. J. Gregg patented a power driven threshing machine of the stationary type, which employed a belt type feeder and a rotary cylinder." (27, p. 1)

"A machine patented by Seth Ballou, of Livermore, in Maine, in 1821, was the subject of patented improvements by Messrs. Boyd and Ketchum, of Pennsylvania, in 1825, by the inventor in 1826, and by George Jessup, of Troy, New York, in 1830. During the latter year the large number of 34 patented inventions connected with the threshing of grain were recorded, and in the following year 38--the largest number in any year of the period be-

fore mentioned. Many of our most ingenious mechanics exercised their skill upon these machines, including Moses Pennock, of Kennett Square, Pennsylvania, the inventor of the revolving horserake; Jacob Perkins, the inventor of the machine for cut-nails, and numerous others. Pennock patented a vibrating thresher in May, 1827." (24, p. 97)

"On March 28, 1822, Mr. A. Savage was issued a patent on a threshing machine designed to be operated by a 'horse power' device. This machine shows the use of feeder rolls, a beating type cylinder, and a down beater positioned in the rear of the threshing cylinder. Immediately below the down beater, he positioned a stationary grate made of slats running transversely of the thresher body, and below this grate a series of stationary horizontal cleaner screens were placed to receive the threshed grain from the grate above. A fan was placed in the front of these cleaner screens to produce a blast of air through these screens to clean the grain of dust and chaff."

"On July 12, 1822, Mr. T. Blake patented a thresher. The drawings of this patent disclose the use of a rotary toothed cylinder and toothed concaves, with a screen below for cleaning purposes. Mr. T. Howe on December 3, 1822, also contributed to the art by improving the cylinder and concave members."

"A year later, on September 18, 1823, Mr. A. Douglas patented a thresher employing a structure very similar to our present day fanning mill, to which he added a toothed cylinder and concave element. On November 25, 1825, Messrs. Howard and Flagg contributed their bit in the way of producing a better proportioned concave element than had been used previously. Mr. A. Douglas, on September 8, 1826, patented a thresher in which he improved the teeth of both the threshing cylinder and concaves. Douglas shows a removable concave unit."

"A patent was issued on May 26, 1827, to Mr. Pennock. Mr. Pennock proposed the use of axially oscillating cylinders of the rotary scrubbing type, and also used a vibrating gravity cleaner." (27, p. 2)

"In 1828" ***** "J. R. Davis built the first stationary thresher that was made in western New York, in the town of Hartland, Niagara County. It was first made with a wooden cylinder, which proving unsatisfactory, was replaced the next year by a metal one." (25, p. 77)

"On April 22, 1831, Mr. A. Richison patented a toothed cylinder in combination with a plain concave and a four-winged down beater, positioned at the rear of the cylinder, said beater having teeth on the outer edge of the wings. Mr. J. S. West was issued a patent on April 26, 1831, on an adjustable concave; this concave is hinged at the rear end thereof in a manner similar to present day practice."

"Mr. E. Warren also contributed to the thresher art on April 28, 1831, by providing an adjustable cylinder bearing. Mr. J. Lammon disclosed the use of a toothed cylinder and a toothed concave in combination with a belt-type feeder to carry the grain to be threshed to the cylinder." (27, p. 2-3)

"A machine patented in January, 1831, by Samuel Turner, of Aurelius, New York, was, a few years after patented in England by a Mr. Atkinson, of Yorkshire. It appears to have been upon the principle of those now"

(1860) "in use, having a drum surrounded by a series of pegs so arranged as to pass a similar row of pegs placed on a concave, surrounding nearly one-half the circumference of the drum." (24, p. 97)

"Yale & Curtis were granted their patent on September 17, 1833, and it is the first steel or iron construction proposed for cylinders and concaves. The cylinder is of the toothed drum type which is mounted upon spiders, which are mounted upon the cylinder shaft. The concave is of the toothed type, and is intended to be cast. The cheeks are of cast iron, and are supplied with integral legs which reach to the floor to support the units."

"Mr. Porter's patent was granted on January 23, 1835, and his disclosures are a good example of the 'Walker' types of modern threshers. The drawings disclose the use of toothed cylinder and concaves, reciprocating straw carriers, and a fan type operated cleaner. Parsons' patent was issued on July 2, 1836, and is very interesting. He used a toothed cylinder and a toothed concave, a system of rotary straw carriers and separators, a cleaner of the fan type and a bulk grain bin. In the year of 1837, on December 26th, A. W. Bowling was granted a patent," ***** "on a threshing cylinder, the construction of which is the forerunner of our present-day cylinder. Mr. Bowling used cast iron cylinder heads which were united by bars of wrought iron; these bars were provided with openings through which tapered, square shanked, threaded and cylinder teeth were passed, and secured in place by a nut on the threaded end of the tooth, which is the exact method used in modern threshers and combines."

"Ross shows the use of back feed, cut off block, and in patent to Currier, the cell belt or grain carrier was introduced in combination with toothed cylinder and concave, a slat-type rotary straw carrier, a vibrating cleaner screen, and a fan to furnish the air thereto." (27, p. 3)

"The Pitts Brothers - Hiram A. and John A. - of Winthrop, Maine, were the first American inventors who were successful and practical in this line, whose inventions went into general use and have come down to this day." (1894) "H. A. Pitts, in 1830, patented an improvement on a railway or tread power, which consisted in the substitution of hard maple rollers under the movable platform, connected by an endless chain, for the old fashioned leather belt. He and his brother, John A. began the manufacture of these improved powers on a small scale in their native town, and introduced them in the State of Maine, and to some extent in other New England States. They became popular for giving power to the 'ground-hog' thresher, as the open cylinder machine was called there. While operating these machines, H. A. Pitts conceived the idea of combining the old 'ground-hog' and the common fanning mill in a portable form. In 1834 he completed a machine on this plan which operated successfully. After various improvements had been made by him and his brother during the intervening years, a patent was granted to them December 29, 1837, for their thresher, which was the original of the great family of 'endless apron' or 'great belt' Separators. This first machine though quite different in appearance from those of the class as constructed at the present" (1894) "day, had all their essential features. It did not have a 'second carrier' or open raddle; the apron ended at the picker; the beater was round and armed with pegs; the

picker was of the same form, but smaller, and its office was to throw the straw off from the machine; and the elevator did not return the tailings to the threshing cylinder, but emptied them into the sides of the machine over the return board or sieves for re-fanning."

"The invention of the Pitts Brothers marked a distinct era in the history of threshing machines; and although various improvements have been made in the details of this type of threshers, it is a remarkable fact that they followed the principles covered by the original patent all the way down for more than half a century. They manufactured these machines in company until 1840, when John A. Pitts went to Albany, then to Rochester, New York, where he connected himself with Joseph Hall, another pioneer. Next he went to Springfield, Ohio, and finally to Buffalo, New York, where he died in 1859." His machine was known as the 'Buffalo Pitts,' it is said.

"Hiram A. Pitts remained in Maine until 1847, when he removed to Alton, Illinois, where he began the manufacture of threshing machines. He built a good many at that place, improving and perfecting them from year to year. In 1851 he removed to Chicago, and in 1852 put upon the market his first threshers from that point. During the years following a large trade was established, and his machine - known as the 'Chicago Pitts' - found a market wherever grain was raised to any extent. He died in 1860."

In February, 1836, "E. Briggs and C. G. Carpenter patented a traveling thresher, which could be used with or without a grain-cutting attachment. It ran on four wheels, like wagon wheels, and depended upon the traction of the two hind wheels for power." (16, p. 105-106) (This machine, and also the D. A. Church harvester and thresher, patented May 14, 1841, having been classed as harvesting and threshing machines are included under Harvesting Machines.)

"About 1830 Jacob V. A. Wemple, of Montgomery County, New York, a blacksmith and wagon-maker, became interested in threshing machines on account of repairing some of the crude machines in use then. He invented an open-cylinder or 'bull-thresher' and a horse-power to go with it, and began manufacturing at Mineyville, New York. The peculiarity of the thresher was in the shape of the cylinder teeth, and in the manner of fastening them to the cylinder. The horse-power was of the stationary type. About 1840 he entered into partnership with George Westinghouse, whose son was since the inventor of the celebrated air brake for railroad cars. Together the two inventors and mechanics worked out a separator differing somewhat from that of the Pitts Brothers', in this chiefly, that it had a short-slatted canvas carrier that delivered the threshings upon a traveling sieve or riddle, which was given a vibratory movement by running over square tumblers or rollers, the grain and chaff shaking through, the straw being carried over. They obtained a patent for this machine, which was afterward known as the Wemple thresher, July 13, 1843. They were then manufacturing at Fonda, New York. Mr. Westinghouse soon after withdrew, going first to Central Bridge, and afterward to Schenectady, New York, where he permanently established himself. He continued manufacturing threshers, after the Wemple principle, for many years. He also built at an early day an open-cylinder 'ground-hog' thresher, with a vibrating separating attachment." (16, p. 106, 108)

"The great exhibition in London, in 1851, gave an immense impulse to the use and construction of agricultural machines in England and America. Europe was on that occasion first made acquainted with the extent and ex-

cellence of American inventions in this department, in which our greatest triumphs were achieved. A great variety of threshing machines were there exhibited, adapted to steam and horse power. All the English horse-power machines required from four to eight horses to work them. Only one, which was exhibited by the Messrs. Allen, of New York, was operated by a single horse."

"In July, 1852, under the direction of the executive committee of the New York State Agricultural Society, an extended and thorough trial of agricultural implements, lasting eight days, was made at Geneva before a select committee. Trials were on that occasion made of simple threshers entered by" (five manufacturers) "and of threshers and separators combined" by an equal number of manufacturers. "Nearly all of this large number from a single State" (New York) "were found to be highly efficient machines." ***** "The horse power exhibited by the same manufacturers was also subjected to careful tests. They were both upon the chain or railroad principle, and upon that of the sweep or lever, and cost about \$100. each." ***** From the foregoing it will be seen that "an immense gain had been effected in the economy of threshing over the most approved methods and instruments in use in England and America only forty or fifty years before" - (about the beginning of the 19th century -

"The World's Fair in New York, in 1853, brought together also splendid illustrations of the progress of the United States in the application of mechanics to the business of the farm. There was a good representation of threshing machines, of which the following were the principal, which may be supposed to exhibit the highest perfection which the instrument had then attained. The 'Farmer's Labor-saving machine,' for threshing, separating, cleaning and bagging grain, ready measured for the market at one operation, was designed for two horses, and was said to be capable of threshing and cleaning 100 bushels per day. It was patented in June, 1848, by E. S. Snyder, of Charlestown, Virginia, who also exhibited the model of another thresher with an upright cylinder."

"The rotary seed and grain thresher, with revolving flails, invented by R. W. Palmer, of North Carolina, possessed some new features; and a machine on the old spiked-cylinder plan, submitted by the same manufacturer, contained several improvements. Mr. Palmer took out a patent in England in 1853, and in the United States the next year."

"Hathaway's combined threshing, hulling and cleaning machine for all kinds of grain and seeds, patented in 1848 by Bradford G. H. Hathaway, of Yates County, New York, was said by the inventor to be capable of threshing and cleaning 600 to 800 bushels of wheat in a day. Gilbert's Excelsior thresher and cleaner, patented by Joseph C. Gilbert, of New York, possessed some peculiarities in the construction of the cylinder, for which superiority to all others was claimed." ***** (p. 98) "The improved threshing and separating machine, patented by J. R. Moffit, of Piqua, Ohio, differed in many respects from any other. It was a powerful machine with much complicated but ingenious mechanism. Moffit's machine was introduced in England soon after the New York exhibition." (24, p. 97-98)

"There was no difficulty in getting most of the grain from the straw with the early plans for separation, but all the while the strife has been to provide devices the best and surest to save the little left. The early British machines and those of the same type constructed in this country sought to accomplish this by combined beaters and pickers, which beat and

tossed the straw along over concave grates or stationary raddles, through which the grain fell. It is claimed that about all the grain was obtained by these devices. An improvement was inaugurated and established by Pitts, whose general plan was to carry the threshings along upon an endless ascending belt having more or less of a vibratory or jarring motion while running, by which the grain was caused to settle through the straw, the process being aided by pickers and beaters operating upon the moving mass. These principles when fully developed, seemed to be capable of saving substantially all the grain. But perfection had not been attained, and a series of experiments upon still other methods of separation culminated in what is commonly recognized as the 'vibrator.'"

"Early in the 'thirties' Pitts used a perforated board or platform, which was shaken longitudinally, in connection with the 'ground-hog' thresher, while experimenting, and before the adoption of the endless apron. George Westinghouse, at a later period, used a pan in a similar manner. There is no doubt that separating devices to be shaken longitudinally were attached to the old 'ground-hog' or 'bull' thresher, at various times before separators, as a class, were generally used. A patent was granted to W. Pierpont, of Salem, New Jersey, May 7, 1850, on this principle, but Cyrus Roberts, then of Belleville, Illinois, was the first to invent and carry forward to successful completion devices necessary to the development of the modern vibrating type of threshers."

"It seems that John Cox and Cyrus Roberts commenced to build tread-powers and 'ground-hog' threshers at Belleville along in 1848 or 1849. During the second year they added a vibrating pan or separator, to take the place of the forkers and the men who pitched the straw away. This addition to the machine was set on legs, loosely, so as to vibrate backward and forward by the action of a crank and pitman attached. It was made of lumber, consisting of sideboards and a plain bottom the width of the cylinder, six to ten feet long, and bored full of holes. The vibration caused by the crank motion shook the grain and chaff through these holes, making a partial separation only. It did not dispense with the forkers, as they still had to help get the straw away with their forks, but it assisted materially in the operation of separating and dividing the grain from the straw. There was no fanning mill as yet to the machine, no frame-work, decking nor covering, but in a short time a frame was added, and to this the vibrating pan or separator was suspended by rods. Other improvements were made, and, July 20, 1852, Mr. Roberts obtained a patent on the machine, the first claim of which was as follows:- 'Having thus described my improvements in grain separator and cleaner, what I claim therein as new, and desire to secure by Letters Patent, is the combination of the adjustable crank for vibrating the separating trough with the adjustable tracks on which the jumping roller runs, which shakes the trough up and down, whereby the straw may be accelerated or retarded without affecting the vertical shaking of the straw.' March 23, 1856, they obtained a patent for the shaking fingers, which had been added meantime. This thresher was developed into a first-class machine, known at first as 'Cox & Roberts' thresher.' The Cox & Roberts thresher was also manufactured by Kingsland & Ferguson, of St. Louis, Missouri, who were among the first to adopt this principle, and were prominent in the early struggles to develop and establish it." ***** "The development of the Cox & Roberts machine was slow, and no great headway was made in the establishment of the

principle until in 1858, when Nichols & Shepard, who had been manufacturing agricultural implements at Battle Creek, Michigan, since 1848, commenced to build threshers upon this vibrating principle. Their plan was to let the straw pass from the threshing cylinder directly upon successive ranks of lifting fingers, to which was imparted a sudden up and down motion, by means of which the straw was thoroughly agitated from the moment it left the cylinder until it reached the end of the machine. Their first separator had but one 'shaker.' It gave good promise, but, of course, was more or less crude, and defective in operative qualities. John Nichols gave the machine the trademark name 'Vibrator,' and devoted his attention particularly to the details of its development. The next year, 1859, 'double shakers' were put in the machine. They counterbalanced one another, thus stopping the end-shake, and they also greatly assisted in separating by allowing the grain to drop through the slatwork of the upper shaker into the conveyor-shaker below. At this time the cylinders were built of wooden staves bolted to iron heads, the teeth (of the old form, patented many years before by Fox & Borland) being driven in, or of wrought-iron bars provided with teeth and attached to cast-iron heads and center-piece. Usually but six bars were used, and it was found that the bars, with their teeth, were too far apart, causing the straw to be jerked from the hands of the feeder, and carried through before being threshed clean. They then adopted the iron cylinder, but added more bars until they built the 'twelve-bar cylinder.' They kept on building and improving their vibrator, encountering and overcoming many obstacles in construction until 1864. About this time the machine attracted the attention of H. H. Taylor, of Chicago." ***** "He negotiated with Nichols & Shepard and obtained an interest in their patents and shops". ***** "A year or so after, C. Aultman, of C. Aultman & Co., Canton, Ohio, manufacturers of the then celebrated 'Sweepstakes' thresher, bought an interest in the vibrator patents, and in connection with Mr. Taylor established the Aultman & Taylor Company at Mansfield, Ohio, in 1867." (16, p. 108, 110 and 112)

The trademark name of the machine built by the Aultman & Taylor Company was the "Starved Rooster." (16, p. 217)

It is stated in (13, p. 15) that "The trade name ('Vibrator') of the latter" (the Nichols & Shepard threshing machine) "was chosen by John Nichols in 1858, the year the Company built its first machine embodying the vibrating principle. This radical departure from the type of machine then in use, the Pitts endless apron, was vigorously opposed by the manufacturers of the latter, but, confident that the vibrating principle was better, Nichols & Shepard made an aggressive fight for the business and won. Eventually the vibrating principle was universally adopted and from it was evolved the present" (1928) "type of machine." (13 p. 15)

In an article entitled "Apron-type thresher as designed 70 years ago" appears a drawing (apparently of a J. I. Case thresher as constructed in 1863) accompanied by the following description:- "The type of machine shown is what was known as the 'apron' or 'endless apron' type, the apron being a cell belt made of strips of wood set on edge and nailed to a canvas, so as to make three-sided cells, into which the grain was supposed to fall while the straw rested on top of the edges of the slats. In addition to the apron, the straw passed over a raddle rake, which was vibrated by square pulleys and cam-shaped bumpers to aid in the separation. The machine had a side shake shoe with shaking grain and elevator spouts. Seventeen

years later - in 1880 - the Case Company began the manufacture of a modern vibrating straw rack type of thresher, and a few years later the apron type was generally abandoned in favor of the more modern type."

"The threshers of that time were all wooden machines. Years later, in 1904, Case came out with one of the first all-steel threshers, which is today" (1933) "the type of thresher manufactured by most builders." (15, p. 20)

"Since some time in the 'fifties' there has been no material change in the design of American threshers, nor in the basic principles utilized in knocking the grain from the straw, and in separating the two. We still have the spike or peg tooth cylinder, and the 'vibrator' or oscillating racks which succeeded the former Pitts apron type of separators. About the only developments have been in the supplemental devices - feeders, wind-stackers, weighers, etc.

"Some ten or more years ago Felix Schlayer came to the conclusion that it ought to be possible to assist the rather weak force of gravity upon which we depend to separate the grain from the straw by utilizing a certain amount of centrifugal force as well. Out of this idea came his experimental rotary thresher upon which he has worked for years, and the latest machine is now" (1932) in the United States being demonstrated to the various manufacturers of threshers and combines." ***** According to the illustration of this thresher, "the machine has separate discharge for the chaff and the straw, according to Continental practice where chaff for feed is highly regarded. Any waste of grain would be evident at either the chaff or the straw piles, or both." *****

"The threshing is accomplished by series of staggered paddle arms revolving on the shaft at 650 R. P. M. Steel rods about the size of No. 9 wire are attached to the end of each paddle, and extend beyond it to a point where the rods just clear the inside housing baffles. The paddle faces are not set at right angles to the direction of rotation, but each is turned slightly toward the discharge end of the machine so as to bat the grain and straw in the direction of travel. This movement of the threshed material is further aided by the blast set up by the rotating paddles. Backfeeding either of straw or blast is prevented by the spiral form of the intake housing, which forces the material to the side before it can rotate to the feeder intake. In other words there is wide clearance below the feeder intake point, but practically no clearance above it. The straw has to go in the right direction."

"In the central part of the threshing chamber there are series of longitudinal baffles which the paddle rods just clear to increase the threshing action, with transverse baffles to vary the speed of the material going through the machine. The action is one of acceleration, with deceleration at the baffles. This prevents the straw from matting at the periphery of the machine by centrifugal force, and produces a periodic fluffing action in the straw. The outlet blast is further controlled by a large metal cone mounted on the central shaft at the discharge end, with the wide base of the cone facing the intake end of the machine, and the small end of the cone at the outlet where the straw passes to the stacker fan. The entire bottom half of the threshing chamber serves as a grate through which the grain passes at any time between the first striking of the bundle at the intake up to the discharge end where the straw is picked up by the stacker fan. The grain which has fallen through the grate is moved by an auger to the rear of the machine where it is cleaned." ***** "The straw was broken up into lengths averaging about 4 inches." (14, p. 16-17)

Winnowing.

"The first step in the mechanization of threshing was the introduction of a fanning mill for winnowing. Although the winnowing fan appears to have been introduced into Scotland from Holland early in the eighteenth century (1710) winnowing in a crude manner by hand was still the general practice in the United States a hundred years later. The earliest and crudest method for separating the grain from the chaff after it had been threshed out by flails or trodden out by horses and the straw raked off, was to toss it up in the air on a windy day. A practice more frequently mentioned by writers beginning about 1790 was winnowing with a sheet. William C. Howells describes as follows the practice in one of the best 'improved' sections of Ohio about 1820: 'It consisted of passing the wheat and chaff through a coarse sieve or riddle upon the barn floor, while two persons took a sheet between them and by a particular flapping of the sheet produced a breeze that blew the chaff away.'" ***** "After the chaff was removed the wheat was further cleaned by the use of riddles or sieves. The use of different sized mesh also served to grade the wheat after a fashion." *****

"Deane, writing of New England about 1790 says, 'Of late the fan is almost out of use.' Deane's statement points to the considerable use of the winnowing fan in New England at a date prior to the decline of the production of bread grains in that region. Miller & Wells state in their History of Ryegate, Vermont, that, 'The first winnowing mill was brought into Haverhill about 1815; probably not earlier, here.' An article in the Ploughboy for 1819 says of the fanning mill that 'It is too well known to require description,' but Howells, writing of Pioneer Ohio about 1820, states that winnowing with a sheet 'was the only method in use except by the larger farmers, who trod out the grain with horses and cleansed it with a fanning mill.' Reynolds, writing of the outlying Kaskaskia settlement in Illinois about 1810, states that the American as well as the French still winnowed with a sheet." ***** "The editor of the Cultivator writes in 1842, 'Of fanning mills there are an almost endless variety,' ***** 'all of which will perform good work, principally differing in the rapidity of execution.' In Virginia there were by 1842 eight to ten different kinds of fanning mills in use." ***** "Wherever the threshing machine was being used, winnowing by the old method was so slow as to be out of the question, and" ***** "threshing machines began to be employed to a considerable extent in the eastern grain growing districts by the late thirties."

"With very few exceptions the manner of threshing wheat and the other small grains in this country prior to the introduction of the threshing machine was either flailing by hand or treading with horses."

"The careful Pennsylvania Dutch farmers had their treading done on wooden floors specially constructed for the purpose. This was also largely true of the other farmers in the well settled districts in that State and in New York. The pioneer farmers in these States, and in the States further West, however, usually did their treading on the bare ground." (21, p. 154-160)

Andrews is the authority also for the statement that "The earliest methods of performing this operation" (winnowing) "was by merely allowing it" (the grain) "to fall from a shovel through a current of air; the wind carried off much of the lighter material, and the corn fell down much cleaner. This had to be repeated several times; a large wicker fan was at first used to create a draught, and afterwards a sort of reel upon which was fastened, by one edge, pieces of canvas:- these as they revolve, cause considerable draught, the corn during this time being sifted through wide meshed sieves called ridders, and during its passage to the ground the lighter particles

are blown away; this operation takes place between the two doors upon the threshing floor of the barn."

"The general form of the ordinary winnowing machine," ***** "consists of a blower, or revolving fan, which is placed in a peculiarly-shaped box, and, as it revolves, sucks in the wind at each side, where apertures are left for the purpose, forcing it through a sort of tunnel and out at the other end. On the top of the machine is placed a hopper, with a shuttle to regulate the quantity that passes from it; below this, in the tunnel, are placed one or more sieves of different degrees of fineness; these have a shaking motion communicated to them by a crank and rod attached to the other part of the machine in motion. As the corn falls through from the hopper it meets the current of air from the blower, by its weight overcomes the resistance to the blast and passes down an inclined plane, falls out at the after end of the machine, while the chaff and very light materials are blown out at the fore end; the light corn of different qualities, as well as the seeds, are separated by divisions, and each is brought separately out at its proper place."

"The modern winnowing machine is a very cheap and efficient apparatus for cleaning corn. It was invented by Mr. Gooch, of Northampton, in the year 1800, and is manufactured" ***** "by most of the principal implement makers. Messrs. Hornsby have received several prizes for these machines, and have improved them considerably by fitting a spike roller in the hopper, the spikes working through bars placed crosswise in it. The object of this is to enable the machine to clear the corn in the state in which it comes from the threshing machine without being riddled; for the second time of passing the corn through, the roller is thrown out of gear and a board placed over the grating; it then becomes an ordinary machine, but of superior capabilities. A double-shaking screen is also fitted, which more effectually cleans out all small seeds and dirt." (1, p. 126-127)

Feeders.

"Grain separators were quite thoroughly perfected before the feeders came into extensive use. In fact it has only been within the last dozen years" ***** (The article here cited came out in 1912) "that grain feeders have come into general use, which is merely another way of stating that it has only been within that time that they have been sufficiently well developed to meet the needs of the business." *****

"The first mechanical feeders that were made had many of the features which are common today," (1912) "although the mechanism has changed considerably since the first machines were invented." ***** "One of the earliest forms of feeders which was placed on the market, and one of the first to obtain recognition, consisted of a revolving riddle which carried the grain to the threshing cylinder. Just before reaching the cylinder the bundles were delivered upon a spring supported platform which was slotted. Fingers from below came up through these slots and acted as retarders for the lower side of the bundle. Immediately above this spring platform there was another revolving riddle, working in an almost vertical position, but with the lower end pointing toward the cylinder. This riddle was provided with spikes, which as they revolved around, caught the straw from the upper part of the bundle, and delivered it rather high up on the threshing cylinder." *****

"Here we have the main element of the modern successful feeder. The bundles were delivered to the threshing cylinder by means of a revolving riddle; retarders prevented the bundle from going directly into the cylinder, and a device was arranged to feed the upper straws into the threshing cylinder first. There was a revolving disc having teeth which caught the bands of the bundles

and brought them up against stationary knives. Here we have a crude form of band cutter. The feeder was also provided with a governing mechanism which depended for its action upon the volume of straw going into the cylinder. When the amount of straw which was delivered to the spring mounted feeding board passed a certain predetermined amount the spring became depressed, the board moved downward and operated a lever which disengaged a clutch and stopped the main feeding raddle. Just as soon as the bundle which operated the governor was disposed of the spring platform rose and the feeding raddle again started to work. In this machine" ***** "there was no means for spreading the straw uniformly across the cylinder. It possessed many mechanical defects not found in feeders at the present time" (1912) "but aside from the one thing mentioned it possessed all the requisites of a modern self feeder." ***** "The self feeder made fast threshing possible, because it replaced uncertain hand feeding for the more perfect and tireless work of a machine." ***** "The self feeder did two other things that perhaps more than anything else led up to its rapid introduction, and these were that it dispensed with the services of two men;" ***** "and it increased the capacity of the entire machine." (2 p. 36)

The Parsons feeder "was first placed on the market in 1892, and was one of the first to gain recognition generally among threshermen. During the first years of its existence it met with the usual opposition accorded to all new inventions, and not the least of these was the hostility of men who operated threshing machinery." According to the article cited there seems to have been a tendency to crowd the machine beyond its capacity, which was an easy thing to do as "it was not at first equipped with a governor acting on the feeding raddle." ***** "While it had to meet and overcome opposition in the beginning, this was effectually done in the course of a very few years. Another difficulty that was even harder to overcome was that of perfecting the details to meet every condition of grain. To do this it was imperative to build a machine that would be adjustable in all its parts to accommodate the different kinds and conditions of grain, and sizes and bundles found in various parts of the country. These conditions made it necessary to equip the feeder with a governor and with a variable speed device." ***** "Minor changes and improvements have been made from year to year, but all of the distinguishing features such as variable speed device, governor, etc., were incorporated by the end of the year 1895." ***** "Like all other feeders it is equipped with a revolving raddle which carries the bundles to the cylinder. This endless rake or raddle consists of two sprocket chains to which are attached hard maple slats armed with teeth that project backward to facilitate their drawing out of the bundles easily when the latter are delivered at the cylinder of the separator. These teeth serve the further purpose of holding the lower part of the bundles when they pass under the knives of the band cutter." ***** "To better adapt the feeder to different conditions of grain the speed of the raddle may be varied at the will of the operator, that is it may be made to feed fast or slow as desired, but at all times it runs slower than the knives and separating device of the machine. This is done with the purpose of retarding the lower part of the bundles and causing the straw to be fed from the top of the bundle."

"This variable speed is obtained" ***** by means of "a small rubber faced wheel" ***** which "engages by means of frictional contact with a large flat disc." ***** "When the small wheel is at the outer edge of this disc, the latter is driven slowly, but when it is drawn nearer the center

by means of the speed changing lever," ***** "the disc is driven faster. This disc is keyed to a short shaft which is geared to the raddle, and thus causes it to revolve faster or slower as the case may be. The small driver receives its motion from the bevel gears and cross shaft, " ***** "and they in turn are driven from the cylinder shaft by means of a belt on the opposite side of the machine." ***** "This operates in connection with a governor of the ordinary Pickering type which operates a clutch." ***** "When the cylinder speed reaches a certain predetermined number of revolutions for which the governor is set, it operates in the usual way. The balls fly outward on account of the centrifugal force acquired through rotation, and throw in a clutch which causes the small rubber faced wheel to rotate and so start the raddle rakes in motion. It will thus be seen that the feeder will not begin delivering straw to the separator until the cylinder has acquired threshing speed. By a reverse series of operations, if the cylinder falls below its normal threshing speed the governor will again operate and prevent the operation of the feeder raddle."

"The bands are cut by means of a set of serrated knives like those used in the cutting bar of a mowing machine, and driven from a multiple crank shaft. The rear end of the knife bars has an oscillating motion on account of the way they are hung from the top of the frame work by hangers, while the front end receives a rotary motion from the crank shaft. Immediately back of the knife sections there is a set of fish backs which aid materially in tearing the straw apart, and especially in feeding the top straws to the cylinder first. In the Parsons feeder the normal rate of speed for the knives and fish backs is 260 revolutions per minute." *****

"The Ruth feeder, made by the same company that manufactures the Parsons, is equipped with a governor which is actuated by the retarder cylinder." (3-p. 44)

"The Ruth feeder" ***** "is provided with rotary knife band cutter. The knife sections are made detachable and interchangeable. Their function is merely to cut the bands. They do not have as much effect in spreading the bundles as the knives used on the Parsons feeders. The distinctive feature of this feeder is the governor which controls the volume of straw delivered to the cylinder of the separator." ***** The feeder cylinder is located directly over the threshing cylinder. "Below this and to the right of the threshing cylinder the retarding shaft with its fingers is located. All the straw which is fed to the machine must first pass the feeder cylinder. If a heavy mass of straw leaves this point the feeder cylinder will be slackened in speed, thus operating a trip lever which disengages a clutch and stops the raddle. No more straw, therefore, can leave the feeder cylinder until it has taken care of the mass which has caused the disturbance. The circumferential speed of the feeder cylinder is about 4,000 feet per minute, and of the retarder about 40 feet. Thus it will be seen that the straw from the upper part of the bundle will be combed off and delivered to the threshing cylinder while the lower straws are retarded. The retarder shaft may be raised or lowered while the machine is in operation, thus making the throat larger or smaller as desired. The governing in this machine" ***** "does not depend upon variations in the speed of the threshing cylinder, but in variations of the speed of the feeder cylinder. The thresher cylinder maintains a uniform rate of speed, provided the engine governs properly, while the feeder performs its function of delivering a constant and uniform volume of straw at all times regardless of how large a quantity is thrown upon the feeder platform." ***** "The governor, which is of the Pickering type" ***** "is driven by gearing from the shaft of the retarder cylinder

and disengages a carrier trip that starts the raddle in motion." ***** "The feeder cylinder is light, weighing less than 200 pounds, and is fitted with teeth about an inch and half long. Grain is delivered high up on the threshing cylinder, and in almost a vertical position, that is, the butts of the bundles are elevated."

"Another very successful machine is the Wood Bros., steel self-feeder. The distinguishing features of this machine are the bundle spreader, the feeding forks and the governor." ***** "Immediately back of the upper end of the raddle" (are) "the fingers of the bundle spreader. These have both an oscillating and vertical movement, whose duty it is to spread the bundles evenly the entire width of the cylinder. Immediately behind these are a number of feeder forks, operated by link work from the band cutter shaft. These forks are made adjustable, and can be raised or lowered, thus regulating the size of the throat to the different conditions of the grain. An automatic friction governor mounted on the end of the band cutter shaft regulates the amount of straw delivered to the machine. This governor is very sensitive, and responds to a variation of less than one hundred revolutions of the thresher cylinder. Whenever the speed of the thresher cylinder is reduced, the speed of the governor is reduced a like amount, thus causing the weights" ***** "to approach near the center of the shaft, thus preventing the band wheel" ***** "from rotating. This band wheel drives the raddle by means of a sprocket on the rear side, while the spider which carries the weights is fastened by means of a set screw to the band cutter shaft. When the speed of the band cutter, which is driven from the threshing cylinder reaches a predetermined amount the weights fly outward, and the shoes" ***** "engage with the inner rim of the disc," ***** "causing it to rotate and thereby drive the raddle and feeder forks."

"The Lindsay feeder embodies some of the principles of the Parsons, and also of the other types of feeders which we have discussed. The band cutters are of the rotating type, and are attached to a drum which rotates about 275 times per minute. Immediately back of the band cutter cylinder is another cylinder which acts as a distributor. This cylinder revolves at a much higher rate and feeds the straw from the top of the bundle into the threshing cylinder. The carrier rake extends well down to the cylinder, and the spikes act as a retarder for the lower parts of the bundles. The governor is very much like that on the Wood Bros. feeder." ***** "When the band cutter shaft comes up to speed, the weights" ***** "move outward and rotate the wedge" ***** "which locks the spider to the disc which surrounds it. On the rear end of this disc there is a smooth pulley over which a belt passes which drives the carrier rake." ***** A changeable speed device is "used on this feeder; by shifting the lever" ***** "either to the right or left the speed can be made faster or slower, while if in the middle position" ***** "the feeder rake will be stopped entirely. This speed changing device can be operated by hand while the machine is in motion." (4 p. 50)

According to the authority cited, F. H. Marshall, of Darlington, Indiana, "was one of the first successful inventors of the self-feeder." After some experimenting with a device for cutting the bands he devised one which was patented March 23rd, 1883. The inventor states that after having a full sized cutter made, and given a trial, he found "it was not practical, not because it would not cut bands, but because it was very awkward to operate, and would cut the bands usually at the wrong time." An attempt was made to design an apparatus that would "cut the bands and do the feeding too," thereby taking

the place of three men. After having a model completed it was believed "a full sized machine" would "work equally well on a separator" and a patent was applied for. A half interest in this device was transferred to J. A. Marshall, a brother. The Marshall Brothers "obtained two patents on a band cutter and feeder. The first one was issued January 29th, 1884" ***** "and the second on December 9th, 1884." (5 p. 56)

"In some of the earlier lessons of this series we showed that the development of threshing machinery did not begin in earnest until in the late fifties. It was then that the vibrator type of machine was brought out, and the idea of threshing and cleaning the grain in a single operation was finally worked out. It is interesting to note that at just about this time inventors first began experimenting with the self-feeder. Among the first of these early inventors was a man named Samuel D. Reynolds, of Lane, Illinois, who took out a patent, number 21214, on August 17, 1858. It was a crude device, which was intended to cut the bands and feed the bundles to the separator at the same time." ***** "This was probably the first patent granted in this country relating to self feeders and band cutters."

According to the wording of the above mentioned patent one object sought by the inventor was to eliminate the need for preliminary band cutting, "and enable the sheaves of wheat or other grain to be fed directly into a threshing machine." ***** "The band cutting in my improved threshing machine is performed by a series of blades" ***** "which radiate from the central portion of the cylinder," ***** "and whose cutting edges may be of such a shape as will enable them to perform their work in most perfect manner." (6 p. 44)

A number of illustrations are shown, and a long description of the way the machine was operated is given.

"The first automatic feeder of which there is a record in the Patent Office was patented in 1858." ***** "The idea of the inventor was merely to construct a machine which would cut the bands and feed the grain to the cylinder. The bundles in the Reynolds feeder were delivered to the threshing cylinder by means of gravity. In the Palmer machine which was invented in 1864, we see the first exemplification of the riddle system in combination with a rotary band cutter and a distributor. A number of feeders were invented in the sixties and patents taken out thereon. In several of these machines no riddle was used. The bundle was expected to slide down an incline, passed through a restricted central passage to insure having the band cut by the one central knife, and then spreading out before reaching the cylinder. Spreaders were devised for spreading the straw equally across the cylinder. These spreaders consisted of various ingenious devices, such as discs set eccentrically, spiral wings or webs attached to a central shaft or triangular shaped flat pieces attached to a revolving cylinder having the apex of the angle at the mid-width of the cylinder. In all of the early machines it was deemed essential to have some sort of spreader. The necessity for a revolving riddle, or governors or retarders was not appreciated until thirty of forty years had elapsed. Likewise the necessity for elevating the butts of the bundles, or of taking any care as to the height on the cylinder at which the grain was fed were principles not understood for many years afterwards."

In the band cutter and feeder invented by W. U. Hoover, and patented in 1865, the riddle was "placed above a set of inclined rollers upon which the bundles passed on their way to the cylinder. The rollers were set at an

incline in order that the bundles might all pass centrally over a revolving knife which would cut the bands. After the bands were cut the bundle then was shaken out by vibrating fingers upon a revolving raddle which carried it to the cylinder." ***** "The motion of the feeder could be stopped at any time by disengaging the clutches. This machine of course, did not prove successful commercially, and was never used to any extent."

"In 1865 Valentine and Ridout, of Milwaukee, Wisconsin, took out a patent on a feeding attachment for threshing machines which contained the germ of an idea that is found today" (1912) "in all successful feeders. This feature is the retarder which was designed to operate with a hand lever."***** "At the present time the retarder is operated automatically, and is placed on the under side of the machine to hold back the bottom part of the bundle. The idea in Valentine and Ridout's invention was in the nature of a hand governor rather than that of the modern retarder and must be so considered. It could be set to allow any given volume of straw desired to pass to the cylinder."

"A man named A. W. Lockhart, of Sacramento, California, took out a patent on a wing feeder September 15, 1868. In many respects it resembles the wing feeders of the present time." (1912) "The wings could be raised or lowered as desired. The whole machine could be thrown into operation or not by the movement of a lever."

"In 1870 W. H. H. Young, of Waverly, Iowa, took out a patent" ***** "on an improved self-feeder and band cutter, which contained some features new to the art." ***** "For the first time provision is made to deliver the bundles to the cylinder by means of a raddle which changes its direction after the bands are cut, and which elevates the butts of the bundles before delivering them to the cylinder. The band cutters are merely circular saws. There is a spreader back of the band cutter" ***** "consisting of a triangular shaped piece of iron mounted upon a revolving shaft. Another feature of this machine which differed from others of that period was that the rear edge of the guide plate" ***** "was provided with a flange or cut-off projecting nearly to the carrier belt, which prevented any grain from being carried back and thus lost." *****

"Beginning about the year 1892, development work and invention took on new life, and many patents were taken out. Feeders for the first time were provided with suitable governors that regulated the volume of straw fed to the cylinder. These were not perfected for a number of years, however. Among the first of the modern machines brought out at this time was the Parsons. It appeared on the market for the first time in 1892. The manufacturers make the statement that about all the competition it had to meet at that time was from hand feeders. It was provided with the same endless carrier or rake used at the present time" (1912) "the same form of band cutter knife, and the same kind of apron raddle but aside from these parts it had very little else to identify it with its modern prototype. Within the next five years following 1892 the governor problem for feeders was pretty well worked out, and by the year 1900 there were a large number of feeders on the market." *****

"The feeder, the wind stacker and the weigher are all very recent. While self-feeders were experimented with fifty years ago" (The article cited was written in 1912) "it was only a dozen years ago that the first variable speed governors were attached. The wind stacker is another improvement that is comparatively recent. Its principles were known many years ago, but they were not applied to the grain separator. In fact the

development of the wind stacker business was less a matter of invention than it was a matter of advertising and making the owners of threshing machinery realize that it was such a valuable adjunct to their machines that they could not afford to be without it. It took a number of years to get the trade firmly established." (7 p. 46)

"In the year 1894 the Ruth feeder was patented by David C. Ruth, of Halstead, Kansas, and in 1895 the Parsons patents were allowed." ***** "The preliminary exploitation work had prepared the market for these machines, and during the next few years their sales were very large. By the year 1902 practically every point had been thoroughly covered; they were used universally, and the struggles of the self-feeder were a thing of the past." (8 p. 50)

In Talk 61 of the foregoing series of Practical Talks to Threshermen it is stated that "Another inventor who has contributed largely to the development of the self-feeder is Mr. J. B. Bartholomew, who first filed application for patent in 1898. The feeder which he has developed contains a number of meritorious features, among which may be mentioned the method of attaching to the machine, the folding feature and the governor. In most feeders the bundle carrier table folds under, but in Bartholomew's machine it folds over" ***** "and rests, when not in use, on the top of the machine. The band cutters" ***** "are operated by means of a multiple crank, and are of the reciprocating type. The rear knives travel in the path of a flat ellipse, while the forward sections describe almost true circles. This is due to the method of supporting the rear ends of the knife bars by means of a crank. The governor is of the centrifugal type and is very simple." ***** "It is mounted loosely on the band cutter shaft, and is driven by the feeder knives in operation." ***** "When the governor pulley reaches the required speed the weights" ***** "fly outward, and in doing so force the brake shoes against the rim of this wheel and thus start the feeder knives in operation. The same operation starts the bundle carrier. Consequently in this machine both the band cutter knives and the raddle stop at the same time." (9 p. 36)

Stackers

"For a great many years the handling of the straw as it came from the machine was one of the hardest tasks" ***** "In the days of the old 'ground-hog' thresher the straw came out of the rear of the machine, and had to be taken away by men with forks. Later, an elevating straw carrier was invented operated by a chain drive that carried the straw a little distance away, and elevated it to whatever height the carrier was built for. This contrivance was awkward and unsatisfactory." ***** "Such a straw carrier did not handle the straw very far from the machine, and then only straight back." ***** "It was seen that a swinging straw stacker would be an advantage, but no one succeeded until in 1882 Reeves & Company, of Columbus, Indiana, brought out a carrier, mounted on gas pipe legs from 8 to 10 feet long, that did the trick. This was a great improvement over former methods." ***** "This machine was improved in 1893 by Robinson & Company, of Richmond, Indiana, with a carrier that folded back on the machine, and that could be supported with ropes." ***** In 1884 a machine was brought out by Reeves & Company

which was "mounted on a light wagon truck that carried the stacker. About the time these improvements were being made in the straw carriers by the firm above mentioned, other men were working on what finally developed into the wind stacker of the present time." (1912)

"The first man to take out a patent on a device of this kind was the Hon. James Buchanan, also of Indiana, and a lawyer." ***** "He took out a patent in 1884, built a machine which he called his 'Cyclone thresher,' and exhibited it at the Indianapolis Fair in Indiana. It attracted a great deal of attention." ***** "Many objections were raised." Among the objections were, "First, it added too much weight to the separator; and, second it required much more engine power to thresh the grain. These were the principal objections." ***** "His success, however, led a great many other men to study the problem, with the result that from 1890 to 1896 a great many patents were taken out. While the wind-stacker is one of the simplest devices about a threshing machine, there nevertheless have been more than 300 patents issued to inventors of wind-stackers."

"In 1891, Mr. A. McKain, of Indianapolis," ***** "interested some Eastern capitalists and organized the Indiana Manufacturing Company. This Company acquired the Buchanan patents in 1893, paying the inventor \$1,000, per year royalty." ***** "During the first two years the Company was a heavy loser." ***** "In spite of all the difficulties the wind-stacker began to make friends and the business began to pick up." ***** "They" (the Company) "gradually went out of the manufacturing business, and began to sell on royalties, charging the various Companies \$30. for the privilege of using their patents." ***** "Quite a number of new Companies sprang up and succeeded in doing a considerable business." (10, p. 36, 70)

"The next patent" (of importance) "after the Buchanan patent" ***** "was granted to J. W. Nethery, March 21, 1893." ***** "This machine" ***** "differed from the Buchanan patent in a number of important details. In the first place the fan was placed horizontally, and the straw passed directly into the fan casing through a chute especially provided for that purpose. This principle of having the straw pass directly into the fan has come into quite general use, and is the type of stacker which has been adopted by a large number of the thresher companies. None of them at the present time," (1912) "however, place the fan in a horizontal position. Six patents in all were granted to Mr. Nethery, covering various details relating to the construction of the straw delivery tube, and its rotation and elevation. In a patent taken out in 1894 Mr. Nethery makes use of a worm and worm wheel at the base of the delivery pipe to rotate it in a horizontal direction. In other patents he followed Buchanan's ideas in placing the fan back of the straw chute instead of compelling all the straw to pass through the fan."*****

"A large number of inventors contributed to the perfection of the wind stacker," among whom may be mentioned. "F. E. Landis, S. D. Felsing and E. D. Gustafson." ***** The first patent of Felsing and Gustafson "was granted in 1897. A company was organized to build the stackers, and a considerable business was developed." ***** "In 1895 A. A. Russell and H. A. Russell took out patents on a stacker, and organized a manufacturing company." ***** "Mr. J. B. Bartholomew was another inventor who aided in the development of the stacker. He began experimenting in the late 90's and made application for his first patent in November, 1898. In his machine the stacker fan is placed at the side, and the straw is delivered into the fan by means of an especially constructed chute. By placing the axis of

the fan in a horizontal position he is enabled to drive with a straight belt, thus avoiding beveled gears or quarter turn belts. He also devised mechanism for swinging the straw chute automatically backward and forward, together with special means for telescoping the stacker." (11, p. 36)

Clover hullers.

"In harvesting and cleaning grass and clover seeds there has been great improvement. Not only have the harvester and the horserake taken the place of hand labor, but the machinery for cleaning the seed has attained a much greater degree of perfection than was thought possible even twenty-five years ago." (1874) "The evolution of the clover huller has been gradual, and has progressed step by step towards its present" (1899) "condition. In the early years of the century the seed was separated from the heads with a flail or by threading the straw with horses. Later, milling machines were invented, or sometimes regular flour mills were slightly modified and used for hulling the clover seed. In the American Farmer of 1821," (v. 2, no. 42, January 12, 1821, p. 335-336, and v. 2, no. 45, February 2, 1821, p. 357-358) "Caleb Kirk described a mill for cleaning clover seed. This was made somewhat like a flour mill, but the stones were not allowed to touch. The miller received a toll of one-tenth for his work, and the mills could turn out under the most favorable conditions about 10 or 12 bushels of seed in a day. Several of these mills were established about the country, but many farmers still preferred to tread out the seed with horses, partly to save the toll and partly because the milled seed, not being so clean, brought a slightly lower price."

"Another machine, invented by John Bolton, of Warren, Herkimer County, New York, would clean one bushel per hour when run by water power. It could be built for thirty or forty dollars. Some time before 1831 Thomas D. Burrall, of Geneva, New York, invented a machine that was a long step toward the present huller. It was constructed with a cylinder armed with thin triangular iron teeth, revolving over a bed of perforated sheet tin. Below the cylinder was a fan, which blew out the chaff and light seed. The clover heads were first freed from the straw, and were then fed on to the cylinder. This machine when run by water power cleaned from 2 to 3 bushels of seed per hour. A full description was published in the American Farmer of 1831." (v. 13, no. 5, April 15, 1831, p. 37 and v. 13, no. 9, May 13, 1831, p. 66-67.)

"Other machines were also in use up to 1855, but they did not have huller and fan combined. In 1855 a combined clover huller was exhibited at the New York State Fair in Buffalo. The present" (1899) "combined clover thresher, huller and cleaner is too well known to need any description. There has been a steady advance toward perfection, until today the clover is put in at one end of the machine and clean seed runs out of the other. There are several makes differing more in detail than in principle, and all aiming at the same result - to clean the most seed in the shortest time and at the least expense. The mills in use during the twenties hulled from 10 to 12 bushels a day under the most favorable conditions, and the seed had to be recleaned before marketing. Today a good machine will clean as many bushels in an hour." (19, p. 565-566)

An interesting account of clover hulling in the early days is given by S. Edwards Todd as follows:-

"Only about thirty years ago" (1836) "clover seed was removed from the

chaff by the slow and laborious operation of pounding it out with the flail. A faithful and strong laborer who could ply the flail from morning till night was thought to perform a fair day's work if he hulled one peck, or fifteen pounds, of clean clover seed, during that period of time. In some instances farmers would tread the seed out with horses and colts. The heads were separated first from the straw, then all the horses and colts that could be collected on the farm were put on the barn floor and kept moving round and round, day after day, on the chaff. It was a long and tedious job to hull clover seed. The feet of the animals by constant attrition, wore the chaff through to the seed, and most of it would separate readily from the chaff when it was passed through a fanning mill. After the job was pronounced finished, there still remained one-fourth or more of the seed in the chaff, which was sowed chaff and all. Cleaning clover seed was an exceedingly dirty and unhealthy job, on account of the offensive dust which always arises when the seed is being hulled."

"The first step toward cleaning seed by machinery was accomplished by one of the most rudely constructed machines. It consisted of an upright wooden shaft, about one foot in diameter at the lower end, and larger at a distance of four feet from the floor. A portion of it was turned off true, and covered with pieces of tin punched full of holes. The rough side of the tin, similar to a grater, was on the outside of the shaft cylinder, which made one revolution to one circuit of the horse. This grater-shaft worked in the center of a concave, extending entirely around the cylinder, and the inside was covered with perforated tin, which presented a rough surface. The chaff was forced in at the top, and came out slowly at the narrow opening between the cylinder and the concave at the lower end. With such a rude machine a man and a horse could hull one bushel of clean seed in a day. This was the commencement of hulling clover seed by machinery. After this a cylinder revolving horizontally, and having the periphery covered with band iron, with the surface of the iron prepared like a rasp, was brought into use. The concave was also covered with iron having a rasped surface. The concave of such machines can be adjusted by a screw, so that the chaff is stripped from the seed without injuring the kernels."

According to the authority last cited, G. Westinghouse, one of the early inventors of a threshing machine, was also interested in constructing a clover huller. An illustration of his huller is given on p. 278, concerning which the writer quoted states that "*****"this huller is designed to be used for simply hulling the seed after the heads have been threshed off the straw. It performs the work with great rapidity and neatness. The chaff, when it leaves the huller, contains no seed that is of any value. The combined huller consists of a thresher, huller and cleaner, which are all in one frame, and the whole entirely covered and arranged for use on a wagon. A pulley on the hulling cylinder receives the belt from the power, and belts from this cylinder connect with the other machinery, so that the entire operation of threshing, hulling and cleaning is done at one time. The manufacturers say: - 'We have experimented extensively with different plans of making the hulling cylinder and concave, and have found that for durability and efficiency there is nothing superior to a closely spiked cylinder, with spikes case hardened, and an iron concave, and have therefore adopted this plan in our machines. Particular attention has also been given to the cleaning part of our machines. The sieves are long and wide, and so arranged that little, if any, seed will be carried over them. The shoe that holds the sieves receives a back and forward

motion directly from the fan shaft, requiring but little power to operate it, cleans the seed and delivers it at the side.' ***** 'An elevator is attached to the combined thresher, huller and cleaner, for returning clover to the hulling cylinder which has not been perfectly hulled the first time through.' ***** 'The combined threshers, hullers and cleaners require from 6 to 10 horse power, and the hullers and cleaners two and three horse endless-chain powers, or four to six horse lever powers. Their capacity depends very much upon the quality and condition of the clover, varying with the large machines' ***** 'from ten to forty bushels, and with small ones' ***** 'from five to twenty-five bushels per day.'" ***** "Similar clover hullers are manufactured at Chicago, and other Western cities." ***** "In many localities, where large crops of clover seed are grown, the large combined ten-horse machines thresh and hull the seed at one operation. The tailings are returned to the huller until all the seed is hulled, and the light chaff is carried beyond the tail-board." (23, p. 277-279)

Most clover is threshed with clover hullers, but attachments are usually available for grain threshers whereby they also can be used for threshing and hulling clover. The chief parts of these attachments are special concaves having teeth with corrugated surfaces, and screens with finer mesh. Other special concaves are available for threshing other crops such as peas, beans, and rice. Special adjustments of the cylinder speed and air blast for example, are required for threshing these crops.

Kinds of Power for Driving Threshing Machines.

"All the early threshers were stationary. They were set up in barns or other buildings, and the grain was brought to them like grists to a mill. Sometimes they were driven by water, but generally by what have been called sider-mill horse-powers. These were usually under cover, and were very simple in construction, consisting generally of a center-post, or spindle, pivoted at bottom and top in beams, with long sweep attached, and carrying a very large horizontal master-wheel, generally overhead, which drove a pinion and shaft, and transmitted the power by a belt or tumbling rod to the thresher. The next idea was a traveling thresher with harvesting attachments or without, and these obtained power for their operation from the traction of their ground wheels as they were hauled around the fields. About this time tread or railway horse-powers were introduced, and soon after sweep-powers came into use."

"It is possible that some of the early threshers of British make were brought to America, or that others similar were made in this country quite early in the century. It is said that 'bull-threshers' were used as far back as 1825 or farther, but there is no trace of substantial improvement in them until August 8, 1828, when Samuel Lane, of Hallowell, Maine, patented a traveling thresher with harvester attachments. Another patent was granted to him April 6, 1831, but both were unrestored. The first had an apron carrier, and cut some figure in the suit between Pitts and Wemple many years after." (16, p. 105)

"In the year 1831 two patents were issued for horse power for threshing machines to N. P. Stanton, of Syracuse, New York, and to John Lammon, of Macedonia, in that State. These, which now form an important branch of the business of the manufactures of agricultural machinery, have been the subject of 147 patents up to 1857." (24, p. 97)

"Previous to 1830 several kinds of crude stationary powers had been constructed and used for threshers, and tread (since called railway) powers had by that time become quite practical. These latter were soon after constructed so as to be portable; and the advantages of this principle being obvious, inventors and manufacturers thereafter adopted portability as a chief feature."

"It was a simple process when portability became essential to take down the big wheel and pinion of the old stationary power, to arrange frame and levers, and to extend the horizontal rod along the ground, so that horses might travel over it. Then, when the toothed cylinder was substituted for the old-fashioned barred drum, to provide the increase of speed required through an intermediate gear, that is, to add what is known as the 'jack.' After a portable lever-power had been blocked out" ***** "its use would readily point out necessary improvements; and as use increased and powers multiplied different makers would naturally travel in different directions in the application of such improvements."

"Probably the first down-power was simply a large bull-wheel and a single pinion. It might have been either a spur or bevel-gear, as both had been used on stationary powers. As far back as 1800 a spur master-wheel and pinion, with a pair of bevel-gears connected for increasing speed, all overhead, had been used in a stationary power for a threshing machine, hence one method, at least, of increasing speed in the power itself was pointed out; but it required considerable invention and mechanical skill to get these crude ideas into a successful portable lever-power."

"Doubtless several kinds of fairly practical powers were constructed and used before any showed sufficient superiority to create a type, and probably they were nearly or quite all of the low speed, that is, requiring jacks to give sufficient motion; but as with the 'separator' so with the power, it seems that the Pitts Brothers were the leaders. At any rate the Pitts power was the first to gain general use and to maintain its position, as improved of course, in the market down to the present day." (1894)

"Powers designated by their motions are of two classes - the low and the high speed. The first requires the jack to increase motion, and the second furnishes sufficient speed direct; but this is quite an indefinite distinction, because compound gears, and the rate of speed which may be given by the gears or the cylinder, afford wide scope in the construction of the power itself, so that the line between the two types may not be strongly marked. These powers for threshing machines are now obsolete, but for other purposes are very useful." ***** "Of the early high-speed powers the Planet, the Woodbury, the triple-gear and the Climax were the leaders. The first lever-power used by the Pitts Brothers had the large master-wheel and single pinion with jack; but they were experimenting upon the Climax, so-called, about 1845, when Mr. Carey, who was working in the same room with H. A. Pitts, suggested using two pinions instead of one for the two bevel wheels in the center to prevent heat and wear. The result was the internal gear and the turning of the bevel wheels down, and thus the foundation of the Pitts-Carey power was laid. Mr. Carey made no claims to the invention at that time, but the Pitts Brothers, in honor of his suggestion, had his name signed to the application for patent, taking assignment in full; and afterwards they paid him \$500." ***** "The original iron bridge which joined the two pinions proving too rigid, the Pitts Brothers put on their movable step and adjustable cap to hold both top and bottom of bull-pinion and bevel-wheel. This they patented in 1846. The Pitts-Carey combination became a popular power at once, and retained its hold under various modifications, constructions and names. They were not mounted at first, but had

that distinction at an early day, and have been frequently improved in accordance with current requirements."

"The triple-gear is a high-speed type of power, and is put out in various forms according to the uses required of it." ***** "The Woodbury power has had from the first marked peculiarities. Its construction was such that it could only be used as mounted, for which reason, perhaps, it led in the introduction of mounted powers. It rode into the market on two wheels along in the forepart of the 'fifties,' but did not gain ground very fast, owing to its liability to break; but later, as constructed at Springfield, Ohio, at Racine, by J. I. Case, and by other careful manufacturers it gave satisfaction. Later on it was mounted on four wheels, and was improved and strengthened, so that it had become a sturdy competitor with the Pitts-Carey, the Climax and the triple-gear types, but it was still supposed to lack the strength and durability required for the larger styles of separators. The original Woodbury had but two driving pinions for the master-wheel, one above and one below, on either end of the shaft, upon which was the big spur-wheel; the others were traveling pinions simply. W. W. Dingee, a skillful mechanic and an inventor in this line, remodeled the power by making the idlers working parts of the power, thus putting upon four pinions the strain and wear that previously had been applied to two." (16, p. 112-114)

Portable and traction steam engines.

"The use of steam power for agricultural purposes began in England almost half a century ago." (About 1840) "Patents had been granted more than a century ago to Watt and others on steam engines of portable or traction form, and nearly all the essential elements of portable threshing engines had been invented long before threshers had become well enough known for practical men to operate them by steam power. In 1850 Horace Greeley mentions in the New York Tribune that he had seen at Watertown, New York, a portable steam engine for farm use, and his comments upon its work would indicate that little was known of such engines."

"During the Civil War the high cost of iron and steel made it impracticable to put on the market engines for threshing purposes at a price within the means of farmers and threshermen, and it was not until several years after that manufacturers of threshing machinery turned their attention seriously to building them. As soon as the success of steam threshing was demonstrated, they brought out portable engines, at first of six and eight-horse power, but later on of greater capacity, as the trade demanded. The next important improvement that was made was in the development of a durable traction gear, but many minor inventions have been added. An important step was taken when a form of fire-box was brought out adapted to the use of straw as fuel instead of coal or wood." (16, p. 114)

"The portable steam-engines for farm purposes began, about 20 years ago," (1840) "to be advocated by the Royal Agricultural Society of England, and are now" (1860) "in very general use. They travel with or without threshers attached, from farm to farm to do the threshing and other work. They are from

3 to 8 or 10 horse power." **** "Most of the large farms in England and Scotland have also fixed steam-engines of 4 to 10 horse power for threshing and other uses." ***** "Steam-engines and steam-threshers have within a few years been introduced in Ohio and other parts of the West. A machine of about 10 horse power was several years ago built at Chillicothe, Ohio, and was employed in threshing grain in the fields of the farmers." ***** "Hoard & Brodford, of Watertown, New York, were among the first in this country to manufacture steam-engines for farm use. The specimens exhibited by them at the World's Fair in London were, perhaps, not inferior in merit to the best of a large collection." (24, p. 99-100)

In later years, as the steam engine was improved, it became the chief source of power for operating threshers. With the development of the gas tractor, which began about 1900, this source of power gradually displaced the steam engine on the farm. At the present time, (1949) tractors are the principal source of power for operating grain threshing machines. However one of the smallest threshers can be furnished with a gasoline engine of from 6 to 9 horsepower. An electric motor might also be used as a source of power.

Use of threshers

The invention of labor-saving machines may occur a considerable time before they are accepted and brought into general use. This seems to have been the case with threshing machines. It should be of interest to trace not only the invention but also the introduction of these machines in the United States. As might be expected the early threshers seem to have been first put to work in the Eastern part of the country. Rogin is authority for the statement that "Threshing machines were not yet in general use in the late twenties" (1820's) "even in the progressive grain growing state of Pennsylvania. We have the authority of William Darlington that in Chester County in 1828 grain was 'perhaps, most generally' threshed with the flail, and that 'much' was trodden out by horses, and we are informed that in Bedford County, Pennsylvania, grain was still generally threshed with the flail in 1829. Our information thus permits us to" ***** "put the beginning of rapid extension of the thresher at 1830 rather than at 1825."

"To meet the demand for small, inexpensive machines, which emerged in the early thirties, there arose a tremendous ferment of invention, construction and marketing of threshers. According to the editor of the Genessee Farmer there were 700 different machines in the market by the beginning of 1833." (In a footnote relating to the last above statement it is remarked that "The figure refers most probably to number of patents rather than to the number of different makes of machines offered for sale.") "The large bulk of these were notoriously inferior, both because of faulty design and cheapness of material employed in construction. They began to be widely used at the time, however, in the grain growing regions of the East, and undoubtedly served the purpose of weaning the farmers away from the old laborious methods of threshing grain." ***** "Although by the late twenties Ohio was one of the foremost wheat growing States, according to Burkett, the first threshing machines were not introduced into that State until 1831."

"During the late thirties the threshing machine became truly practicable, as represented particularly by the advent of the Pitts thresher. We may

safely infer that by the early forties machine threshing had practically superseded the other methods in the leading wheat growing regions of the East and in Ohio. In the pioneer wheat raising States West of Ohio it was still quite generally trodden out by horses until near the end of the decade. In 1844, however, the manufacture of the Case thresher had been inaugurated at Racine, Wisconsin." ***** "The development of railroads in the fifties further increased the availability of the thresher, and afforded, moreover, transportation facilities to eastern and export markets. Furthermore by the late fifties, the wide use of the reaper in the western States practically precluded the use of other than machine methods for threshing grain, except in the outlying districts on the edge of the frontier. To sum up, as the Western States became important growers of wheat for the market, they adopted the thresher."

"It is highly improbable that the machines of British design found in this country prior to 1820 did other than merely thresh the grain. The English and Scotch machines advertised in the American Farmer in the early twenties did not carry off the straw and winnow the grain, or the advertisements would have mentioned it. As for the threshers of local design, it does not appear that a practicable combined thresher, separator and winnower was available until the advent of the Pitts thresher in the closing years of the third decade. As far as we have been able to discover, this was also the first machine to come into use which combined the tasks of threshing and separating. The addition of a straw separator is perhaps of greater significance with respect to labor saved than that of the winnowing attachment, since winnowing was, by the time threshers came into use, universally done, in any case, by the fanning mill. The addition of the separator to the thresher, on the other hand, mechanized a task previously performed by hand."

"With the exception of the Pitts thresher, which from the first combined the three operations, it appears that the normal course of development involved first the addition of the separator or straw carrier to the simple thresher, and later the addition of the winnower. The thresher-cleaners, as the machines with winnowing attachments were most commonly called, were always provided with separators, the addition of the winnower to the simple thresher obviously not being practicable." ***** "It was apparently only in the late forties, with the establishment of Hiram Pitts in Illinois, the expansion of Wheeler & Melick's production, the introduction of Emery's machines, and the establishment of John A. Pitts in Buffalo, that the transition from the thresher to the thresher-separator may be said to have been effected."

"It was not until the early fifties that the thresher-cleaner was generally adopted by the itinerant threshermen who operated in the Eastern States. The small farm-owned machines throughout the country continued for a long time to be threshers and separators. Thus Wheeler & Melick" ***** "did not put the thresher-cleaner on the market on a considerable scale until 1853, and continued to sell the overshot thresher and separator, as the machines not provided with winnowers were known, for a number of years afterward. H. L. Emery & Co.," ***** "manufacturers and distributors of machines intended for small horse power, first offered the thresher-cleaner in 1850, continuing at the same time to sell the thresher-separator. Of the nine machines exhibited at the State Trial held at Geneva, New York, in 1852, only four were threshers and cleaners combined. It appears that although E. Whitman, of Baltimore, Maryland, introduced 'several' thresher-cleaners in 1845, as late as 1850 the great majority of the machines used in Maryland and Virginia were still simple threshers."

"One authoritative source states that nearly all the threshers had winnowers attached by the early sixties." ***** "As late as 1872, the Commissioner of Agriculture states that farm owned machines were as a rule not provided with winnowers. By that time, however, only comparatively few farmers," ***** "owned threshing machines." ***** "In addition to general improvement in the machine, making for greater capacity, efficiency, and durability, several specific labor-saving devices were added to the threshing machine subsequent to its development as an effective thresher, separator and winnower," ***** "We are informed in the Census of 1860 that 'nearly all threshing machines now in use have an apparatus for carrying the straw up onto the stack,' and that many were provided with automatic baggers. Coulter tells us that by the middle eighties the threshing machines used in the Red River Valley were all equipped with straw elevators, thus saving the labor of two men formerly required to stack the straw. A machine with an average capacity of 750-800 bushels a day still required, in addition to other help, two men to cut the bands of the bundles, two men to feed the bundles into the machine, and two men to measure and bag the grain. By 1900 most of the threshing machines in the Red River Valley were equipped with automatic band cutters, self feeders and weighers and blowers, thus saving the labor of six more men. Moreover, the machine used in that region in 1900 was equipped with a wider cylinder and rear end, and had double the capacity of the thresher employed in 1885. In order to operate the larger machine, a steam engine with twice the power of the former was necessary." (21, p. 164-172)

The principal improvements made in threshing machines since the beginning of the present century include refinements in design and construction. According to a report published in 1933, which included threshers, a brief summary of the outstanding improvements to this machine approximately as given in the report may be stated as follows:- Stronger cylinder teeth in place of those formerly used, which were troublesome because of their tendency to break, and to bend sideways, "which caused them to strike concave teeth," and made it necessary to stop to straighten them. "Abrasion and field tests prove that resistance to wear has been increased $2\frac{1}{2}$ times." Steel has been substituted for cast-iron in the manufacture of "concaves, cylinder heads, beater heads, elevator boots, etc." All high-speed shafts have been equipped with anti-friction bearings, thereby eliminating "stops for hot bearings, or for lubrication," which results in increased number of hours of work per day. The report further states that "Frequent replacement of plain bearings" has been "eliminated." ***** "Cylinder bearings, the most troublesome in the old days, no longer cause delays. Replacements over a period of years indicate present (1933) bearings have a life $8\frac{1}{2}$ times as great as 1910-14 bearings. Reduction in vibration and longer life of all parts of the machine have been brought about by the use of "counter-balanced thresher and feeder crankshafts." The introduction of steel chains, in 1932, in place of malleable iron on elevator flights has increased durability several times, according to replacement figures, while the possibility of unhooking has been eliminated. "According to running tests under field conditions new worm and worm gear on weigher showed an increased durability of thirty times." ***** "1932 truck wheels were in sound condition after traveling twelve times the distance at same speed and with same load which wrecked the 1910-14 wheels. Tests on castings such as pulleys, bearings and minor parts show that they are $1\frac{1}{2}$ times stronger than those used in 1910-14. All weak sections of the 1910-14 period have been

increased approximately 100 per cent in strength. Wind-stacker fan tests and replacement data on this part indicate that breakage has been reduced more than 93 per cent between 1910-14 and 1932. Substitution of anti-friction for plain bearings has reduced the replacement demand more than 91 per cent. In every part of the thresher, similar improvements have been made. The 1932 thresher does its work with fewer delays and less expense for replacement of worn-out and broken parts. The 1910-14 machine gave good service with a skilled and careful operator, but, with a poor operator, the expense was high, delays frequent, and the life of the machine comparatively short. Its use was discontinued when delays and expense became great enough to make its operation unprofitable. With average operators, the 1932 thresher will give better and longer service." (17, p. 26)

A small thresher of the trailer type was developed by the Tennessee Valley Authority, in cooperation with Experiment Stations and Extension Services of the Valley states, on which commercial production was started by the Turner Manufacturing Company in 1940. This thresher was developed to meet the needs of many farmers with small acreages, including those in hilly and mountainous regions where they have difficulty in getting grains, clovers, and grasses threshed. With a gasoline engine of from about six to nine horsepower, it weighs about 1600 pounds, or about 1400 pounds without engine for power take-off drive. Mounted on two wheels with rubber tires, it can be drawn over ordinary roads behind a passenger car or truck. It is V-belt driven and its cylinder is of the hammer-mill type of construction. It does not have a self-feeder, nor facilities for carrying away or stacking the straw, and lacks other features of the conventional full-size thresher; but it meets the need for which it was developed. In using it the operator would probably ordinarily re-run the tailings, and in the case of clover and other small seeds, he would also re-run the seed through the thresher.

The latest developments in threshers (1949) include the wide use of rubber tires, which enables the custom thresherman to move his machine over highways and from field to field at greater speed; wider use of ball and roller bearings and so mounted as to be more accessible; simplified and improved facilities for lubrication; faced pulleys for more perfect balance; and a decrease in the number of belts required.

Because of the increasing use of combines (harvester-threshers), the production of stationary threshers has decreased during recent years. Following is the annual production of stationary grain threshers in the United States according to the Department of Agriculture for 1920, and the Department of Commerce thereafter: in 1920, 22,669; in 1930, 8,635; in 1940, 1,921; and in 1948, 2,161. In 1948, the last year for which production figures are available, there were 8 manufacturers making stationary threshers with cylinders under 28 inches, and 5 manufacturers making them with cylinders 28 inches and larger. If the trend continued, stationary threshers would become extinct. There are, however, and will probably continue to be certain crops and conditions under which some of them will be needed, and they will doubtless be manufactured in substantial numbers.

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Flailing



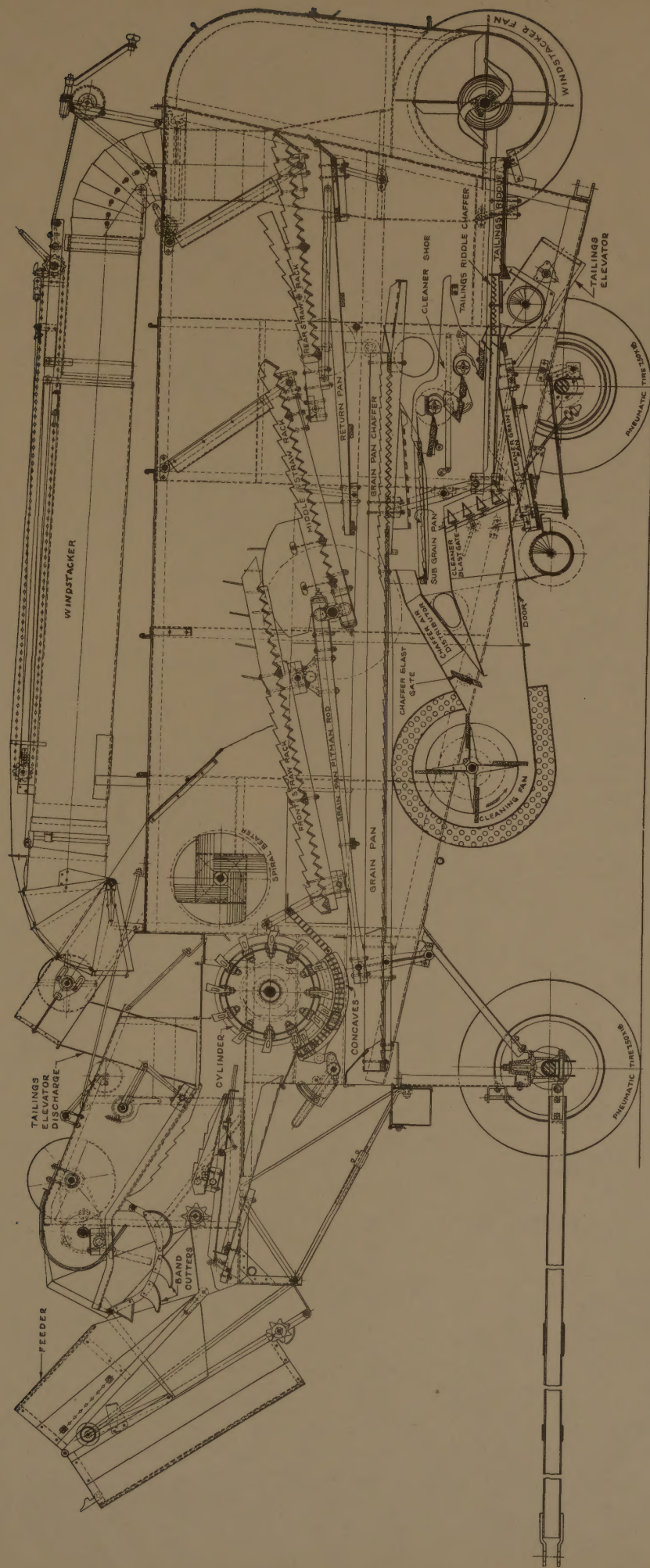
Thresher - sweep power



Thresher - tread-mill power



Modern grain thresher



CROSS-SECTION OF A MODERN GRAIN THRESHER
(Grain elevator not shown)

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